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# LARGEMENT

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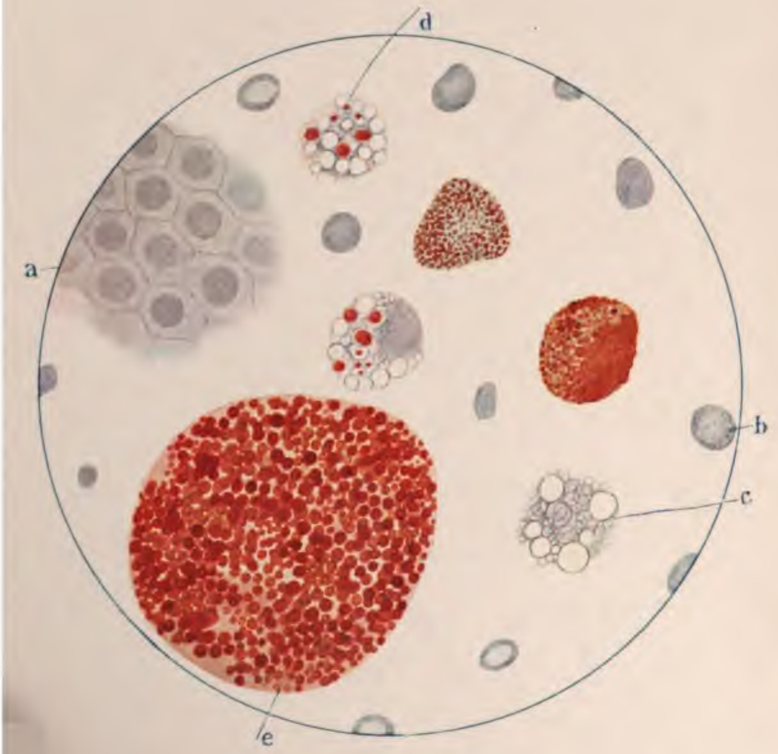

*A.* *Placard of Epithelial Cells.*

*B.* *Red Blood Corpuscle.*

*C.* *Cell containing large numbers of clear spaces (probably vacuoles); will not react with Scharlach R.*

*D.* *Cell containing fat dioplets stained red with Scharlach R. and clear spaces, probably vacuoles.*

*E.* *Enormous Cell loaded with fat.*

*Film of Milky Fluid obtained from a prostatic adenoma. Fixed in formalin vapour and stained with Scharlach R. and haemalum.*

*("B" Eye-piece and $\frac{1}{12}$ obj.)*

OXFORD MEDICAL PUBLICATIONS

# PROSTATIC ENLARGEMENT

BY

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## BACTERIOLOGY

BY

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# PREFACE

THE investigations, the results of which are set forth in this work, were commenced in 1900, and were undertaken to find a satisfactory solution of the success of the operation known as 'total prostatectomy'. The first points to be settled were the structure of the prostate and its relation to its fibrous sheath and to the bladder. It was at once obvious that the normal organ could not be detached from its surroundings by a process which at all resembled that used in the operation under discussion.

A study of the pathological specimens revealed the compression, by adenomatous masses, of the outer part of the organ.

The formation of this envelope seems to afford an easy explanation of the facility of enucleation and the absence of post-operative stricture. The finding of this pathological envelope shows that the operative surgery of any disease must not be considered without reference to its morbid anatomy and pathogenesis as far as this can be obtained.

The examination of many specimens of the prostate, in all stages of enlargement, has enabled some explanation of the more common clinical phenomena to be offered.

The results of castration and of vasectomy have

46505

been summarized, because it appeared that the effects of these operations on the testicle and prostate were but little appreciated. That vasectomy should have been revived in 1894, to produce an effect on the prostate by its supposed power to bring about an atrophy of the testicle, when it had been shown in 1825 by Astley Cooper that section of the vas had no effect on the testis, is a striking example of how work previously placed on record may be completely forgotten.

Now that operations on the prostate are of everyday occurrence, carcinoma of that organ will be frequently met with, and its proper treatment form a subject of discussion for some years to come. It would appear that while in some cases it can be clinically diagnosed with certainty, in other cases its presence is only revealed to the microscope. Another fact which has been elicited, namely the possibility of an enucleable tumour proving carcinomatous, is worthy of note.

The author trusts that he has succeeded in adding something to the knowledge of this common and important disease.

I must express my thanks and acknowledge my indebtedness to Mr. S. G. Shattock for his unfailing kindness, for many valuable suggestions, and for the ready help he has accorded me in the study of the pathology of this disease.

Mr. L. S. Dudgeon has written the chapter on the Bacteriology, and conducted the investigations on which it is based. Without his aid this chapter could not have appeared. To him the reader is indebted for what is, perhaps, the most interesting and least-known aspect of the question of prostatic enlargement.

My colleagues at St. Thomas's Hospital I must thank for placing, not only the clinical details of their cases at my disposal, but also the pathological material derived from them.

Mr. Reginald Harrison has kindly allowed me to make drawings of three tumours which he removed by operation.

My best thanks are due to Mr. Parsons for his help in the preparation of the chapter dealing with the anatomy of the prostate.

Many of the illustrations are from blocks which have appeared in the *Transactions* of the Pathological Society of London, and which the Council have kindly allowed me to use. I have also to acknowledge the same kind permission given to me by *The Practitioner*. Messrs. J. R. Ford and W. T. Shiells have expended much time and trouble on the drawings, from which Messrs. Bale, Son & Danielsson have prepared the blocks.

CUTHBERT WALLACE.

26 Upper Wimpole Street, W.
*June*, 1907.

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# CHAPTER I

## SURGICAL ANATOMY

In considering the normal organ, special attention will be paid to the following points :—

1. Mutual relations of gland tissue and stroma.
2. Relation of the gland tissue to the urethra and the ejaculatory ducts.
3. Relation of the gland tissue to the bladder.
4. Relation of the organ to the muscle-coats of the bladder.
5. Relation of the gland to its fascial covering.
6. Structure of the fascial covering.
7. Form and position of prostatic venous plexus.
8. Structure of the urethra.

The prostate is situated immediately below the bladder and is wrapped round what is anatomically the first part of the urethra. Developmentally, however, the prostatic urethra corresponds to the first and a portion of the second part of the canal. The urethral axis of the organ, which is almost vertical, measures[1] 30 mm. (1¼ inch), the greatest transverse axis 36 mm. (1½ inch), and the greatest antero-posterior axis 18 mm. (¾ inch). The average weight of the organ is 20·5 grammes (4½ drachms).

### EXTERNAL CHARACTERISTICS

The organ is roughly pyramidal, and has been aptly compared to a horse chestnut flattened on one side. Although it is usual to speak of the prostate as showing two lobes, there is hardly ever any indication of such a division to be seen from the outside. The organ has an apex, a base, an anterior surface, two antero-lateral surfaces, and a posterior surface. In addition, two postero-lateral borders, which form the boundaries between the two antero-lateral and the posterior surfaces, may conveniently be described.

---

[1] Quain's Anatomy.

*The apex.* This rests on the triangular ligament and forms the most inferior part of the organ, and into it, with the exception of the base, flow all the other surfaces and borders. A section of this portion of the prostate, taken at right angles to the urethra, is rounded in outline.

*Antero-lateral surfaces.* The two antero-lateral surfaces look forwards and outwards, and are joined together by the narrow anterior surface. Although it is convenient to speak of these three surfaces separately, yet there is no definite line of demarcation between them, the whole anterior surface of the gland presenting a uniform curve with the convexity forward. These surfaces are bounded above by the base, and are separated from the posterior surface by the postero-lateral borders; with the exception of the upper part they are in contact with the levator ani muscle.

*The anterior surface.* Above, it is bounded by the base, below by the apex, and at the sides it flows into the antero-lateral surfaces. It is almost vertical from above downwards, and is convex from side to side. The lateral extent of this surface depends on the shape of the prostate as seen in a transverse section. Thus it is of considerable extent, as seen in Fig. 3, but narrow as seen in Fig. 4. In the mid-line, the actual confines are difficult to define on account of the adherence of the fibrous coverings to the gland in this situation.

*Posterior surface.* This surface, which is in contact with the rectum, is slightly concave from side to side and almost flat from above downwards. It is triangular or sub-triangular in shape, the angles being more or less rounded. It is bounded laterally by the postero-lateral borders, which separate it from the two antero-lateral surfaces. Above, it is bounded by the base, and the line separating the base from the posterior surface is horizontal, and the notch, which is usually described and which is supposed to indicate the division between the two lateral lobes of the prostate, is remarkable by its absence.

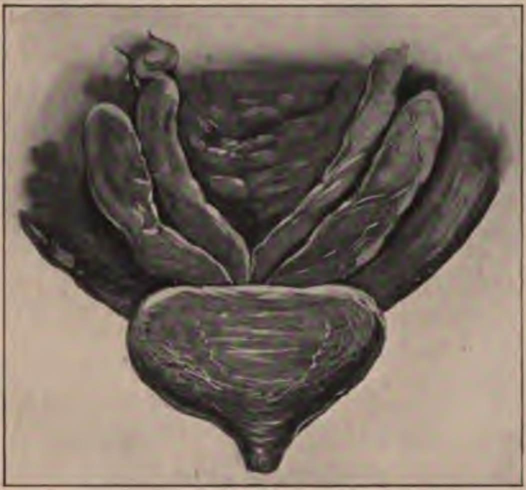

FIG. 1. The posterior aspect of a bladder and prostate. The vesiculae seminales and the vasa deferentia enter the base, and not the posterior surface, of the prostate. The vesiculae pass at first outwards in the vesico-prostatic groove, and then upwards towards the ureters. Between the vasa deferentia is exposed a triangular-shaped portion of the bladder. The direction of the vesiculae are shown too vertical even in this drawing, and the distance, between a line joining the extremities of the vesiculae and the base of the prostate is too great. This is caused by the dissection necessary to show the parts.

*The base.* The upwardly directed base of the prostate is attached to the bladder, and forms the upper limit of the other surfaces. It can be divided into two parts: a central, into which the bladder fibres are inserted, and a marginal, which is free and forms the lower side of the vesico-prostatic groove. The free portion of the base is but little marked in front, the attachment of the bladder-wall being nearly flush with the anterior surface. At the sides the free portion is well marked, and in consequence the vesico-prostatic groove is deep, but in the undissected state is largely filled up with the prostatic venous plexus which lies embedded in the recto-vesical fascia.

Posteriorly (see Fig. 2) the free margin is again divided into two by the entrance of the vasa deferentia and the vesiculae seminales, and it is to be noted that it is the base of the organ which gives entrance to these ducts, and not the posterior surface, as is usually described. The central part of this margin—that is, the part which lies between the bladder and the entrance of the ejaculatory ducts—is convex from before backwards. The posterior part of the free margin—that is, the part which lies behind the ejaculatory ducts—rises as a rule to a higher level than the part in front of it, the prostatic tissue being prolonged up as a thin tongue or sheet, the extreme edge of which fades away in the surrounding areolar tissue (see Fig. 2). The upper limit of this thin tongue forms a straight horizontal line, and shows no division into lobes. The conventional heart-shaped contour of the posterior surfaces of the prostate, as usually figured in books, is artificial, and is made in the attempt to define the vesiculae seminales and vasa deferentia as they enter the gland. In consequence of the extent of the free margin at this spot, the posterior vesico-prostatic groove is of considerable extent, and is filled by the vesiculae seminales and vasa deferentia as they pass out in an almost horizontal direction.

### VESICULAE SEMINALES AND VASA DEFERENTIA

Both the vesiculae seminales and the vasa deferentia at their point of entry into the prostate are tubes of small calibre. Traced outwards they increase in size, especially the vesiculae, which soon attain a diameter of 12·5 mm. In most textbooks the axes of the vesiculae are figured too vertically, owing to the fundus of the bladder being stretched in the process of dissection. As a matter of fact, in the undissected state the direction of the long axis of the organs as they lie in the vesico-prostatic groove is at first almost horizontal, but at the postero-lateral angle of the prostate they turn somewhat upwards to reach the ureter as it penetrates the bladder wall. Here, in addition, they gain a relation with the prostatic venous plexus as it leaves the lateral vesico-prostatic groove to reach the neighbourhood of the ureter. In consequence of the rapid increase in the breadth of the vesiculae, and of their upward direction in the outer part of their extent, the superior border of the vesiculae and vasa deferentia, taken together, is situated at a higher level near the ureter than in the mid-line. A triangular space is thus formed on the base of the bladder. The sides are formed by the vesiculae seminales and the vasa deferentia, the base by a line drawn between the two ureters, and the apex by the prostate at the point of entry of the vasa deferentia. The height of the triangle is small, but varies with the amount of distention of the bladder. In this triangle the rectum and bladder are in contact.

The vesiculae seminales and the vasa deferentia are closely bound to one another and to the base of the bladder and prostate by the recto-vesical fascia.

The length of the vesiculae seminales in the unravelled state is 50 mm. (about 2 inches),[1] but they vary very much in different individuals. When unrolled their length is doubled or trebled. The sacculated appearance is due to the coiling of the tube on itself and to the presence of caecal diverticula.

---

[1] Quain's Anatomy.

In structure they resemble the ampullae of the vasa deferentia. There are two thin muscular layers, an outer, longitudinal, and an inner, circular. The mucous membrane has many fine rugae which form an alveolar structure resembling that of the gall-bladder. The epithelium is columnar, with a deeper layer of small cells. A microscopic section of these organs suggests a gland rather than a reservoir.

## STRUCTURE OF THE PROSTATE

The consistence of the organ is firm. A freshly-cut section is of a pinkish grey colour, and presents a finely granular or spongy appearance due to the intermixture of stroma and gland tissue. Even in young specimens brownish specks due to calcareous deposits in the amyloid bodies are seen, though these are more common in advanced life.

The stroma is composed of fibrous, unstriped muscle, and a certain amount of elastic tissue. The unstriped muscle predominates, and next in quantity comes the fibrous tissue, while the elastic is only sparsely scattered through the organ. These three tissues form a felt-like mass, the strands of which run in every direction, and contain in their meshes the glandular elements.

The glands are of the tubular type. Their walls are much plicated, giving rise to the appearance of many shallow, wide-mouthed alveoli. The epithelium lining the alveoli and ducts consists of short columnar cells, between the outer extremities of which lies a layer of smaller round or polyhedral cells. The epithelium is therefore identical with that lining the urethra. The epithelium lies immediately on the stroma, which in this situation often contains no muscle fibres.

The ducts, twelve to twenty in number, open for the most part on the floor of the urethra, or on the sides of the veru montanum. Sometimes, however, a duct may be seen to open on the anterior wall of the canal (vide Fig. 10).

The structure is best studied by means of vertical and horizontal sections.

*Appearances seen in a vertical median sagittal section.* The shape of the prostate seen in this manner is roughly triangular, the base being that surface into which the bladder is inserted, the apex being the apex of the organ, and the two sides formed by the anterior and posterior surfaces of the prostate. The urethra is seen to penetrate the organ in a vertical direction for the first part of its course, but is inclined forwards below. It lies somewhat nearer the anterior than the posterior surface. Under the mucous membrane of the internal meatus can usually be noted the bundles of the circular coat of the bladder forming the so-called sphincter vesicae. Outside the sphincter vesicae the longitudinal fibres of the bladder, very much more open in texture, can be seen running down and forming a connexion with the base of the prostate. Immediately below the sphincter vesicae, and surrounding the whole length of the prostatic urethra on both sides, is an area more or less devoid of gland tissue to the naked eye. The extent of this varies very much in different specimens, but usually it is most marked posteriorly, below the entrance of the ejaculatory ducts. The portion of the gland behind the urethra is divided near the mid-line, into two by the ejaculatory ducts. Above the ducts and between these and the bladder is an area of glandular tissue, which is continued up, so as to immediately underlie the sphincter vesicae. Below and behind the ejaculatory ducts is again an area of gland tissue which, in the section now described, forms a long narrow area, directed somewhat upwards and backwards. Its summit reaches as a rule to a higher level than the portion in front of the ducts. It is to be noted, that gland tissue is invariably found both above and below the ejaculatory ducts. In front of the urethra is another area of elliptical outline. In most specimens this area is fibrous, but in a fair proportion of cases it shows unmistakable

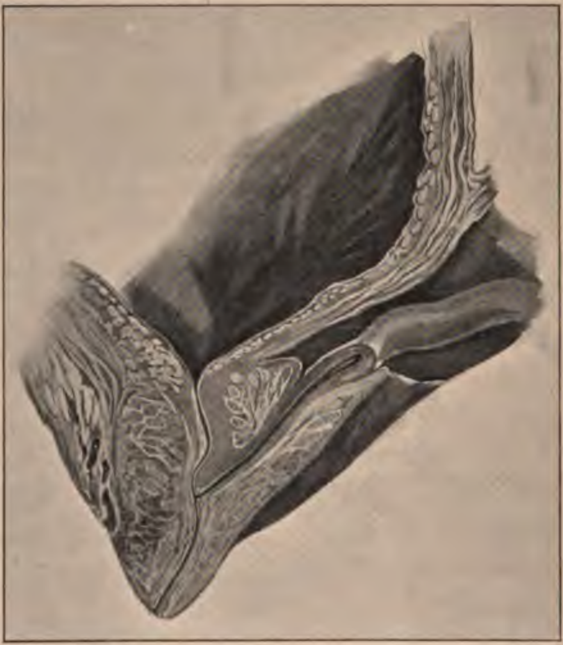

FIG. 2. A median sagittal section through the prostate and the lower part of the bladder. The vas penetrates the base of the prostate, the posterior part of which surface is continued up as a long thin tongue. Behind the urethra there is a gland tissue both above and below the ejaculatory duct. In front of the urethra there is also gland tissue in this specimen, although the section, being median, passes through the anterior commissure. Surrounding the urethra there is an area devoid of gland tissue. Towards the inferior extremity of the organ this area shows signs of longitudinal striation. Immediately in front of the prostate lies the prostatic plexus.

glandular areas. The absence of gland tissue is accounted for by the fact, that a median sagittal section passes through the so-called anterior commissure of the organ, which is formed of fibro-muscular tissues, and indicates the bilateral nature of the gland. The anterior outline of this area is very ill-defined, and it is difficult in many specimens to make a distinction between the prostate proper and the fibrous sheath of the organ, in fact the tissue here has very much the appearance of scar tissue. Embedded in this tough mass, may be seen the cross sections of the veins forming the prostatic plexus. This ill-defined anterior margin of the prostate is probably brought about by the fusion of many structures in front of the prostate, and will be referred to later on. It is sufficient to point out here, the great contrast presented between this surface and the sharply defined margin of the posterior surface of the gland.

If sagittal sections are taken on either side of the mid-line, the appearances differ somewhat. The section now misses the anterior commissure and passes through a part of the prostate which is entirely glandular. The part lying in front of the urethra presents the ordinary spongy appearance of the normal prostatic gland tissue. Behind the urethra, the gland area is no longer divided into two by the passage of the ejaculatory ducts; in fact, the two areas which were described in the mid-sagittal section as lying above and below the ejaculatory ducts, are continuous, and it is only when any section happens to pass through these canals that there is any appearance of a division to be seen. This is important, because the triangular area described as lying above the ejaculatory ducts has been spoken of as a third lobe, but it is, in point of fact, absolutely one with the glandular areas of the remaining portion of the organ.

Sagittal sections taken still more laterally entirely miss the ejaculatory ducts and the urethra, and show a sub-triangular outline, entirely filled with normal spongy prostatic tissue, bounded by the cortex of the gland.

*Appearances seen in horizontal transverse section.*—The outline of a horizontal section, taken a little above the most prominent portion of the veru montanum, varies very much in different organs. Sometimes it is that of a circle flattened from before backwards, sometimes of an ellipse, the greatest diameter corresponding to the transverse axis of the organ. Again, in another case it is roughly triangular, the posterior surface of the organ corresponding to the base, and the apex to the anterior border. Somewhat towards the anterior part of the section will be seen the urethra, which is here crescentic in shape, with the horns pointing backward. Within the horns lie the uterus masculinus, and, immediately behind this, the two ejaculatory ducts. If the surface of the section be examined with a hand lens, it will be seen that the gland tissue is usually absent in certain parts.

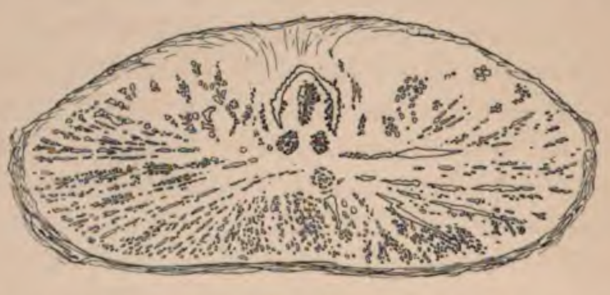

FIG. 3.[1] A microscopic section of the prostate taken immediately above the most prominent part of the veru montanum. The section was projected by a lantern and then traced. It shows the arrangement of the gland tissue, the horse-shoe-shaped urethra, the prostatic utricle, the ejaculatory ducts, the radiating stroma arms, the outer, non-glandular portion of the organ, and the fibrous sheath of the organ. The anterior commissure is devoid of gland tissue. The transverse measurement of this specimen is unusually large.

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[1] I am indebted to *The Practitioner* for the use of this block.

These are :—

1. Immediately in front of the urethra.
2. At the extreme outer portion of the organ.
3. Immediately round the urethra.
4. At a point posterior to this canal.

From behind the urethra, non-glandular strands radiate in all directions to join the non-glandular circumferential portion of the organ. The direction of these strands varies somewhat. From a spot immediately behind the urethra, they pass out almost as straight lines to the circumference. Towards the front they have a disposition to curve forwards, posteriorly they run slightly backwards, while immediately behind the urethra they pass almost directly backwards to the circumference of the gland. The gland tissue, in such a section as is being described, lies embedded and supported by these radiating stroma arms, and is more marked at the sides and behind the urethra than in front. The anterior commissure is usually devoid of gland tissue, and

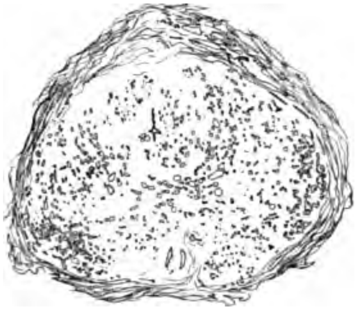

Fig. 4. A microscopic section of the prostate taken close to the bladder. The section was projected by a lantern and then traced. The urethra is situated to the anterior part of the organ and is seen as a linear slit. At the posterior border of the section lie the ejaculatory ducts. The gland tissue is fairly evenly scattered throughout the organ. The stroma shows no definite arrangement. The anterior commissure is not marked, there being gland tissue on the anterior aspect of the urethra. The fibrous sheath and the prostatic plexus are shown. The outline of this section is unusually circular.

the part of the organ immediately on either side of it may be but sparsely supplied with it. In a certain number of prostates, however, the gland tissue is found to lie immediately in front of the urethra. Its presence here is important because it will be seen later that, in some cases of prostatic enlargement, adenomatous masses completely surround the urethra.

The outer non-glandular portion is a thin layer of stroma which everywhere covers the organ. It rarely exceeds ·5 mm. in thickness. Owing to the different names used a certain amount of confusion has arisen. To this outer layer the term 'capsule' has been applied. This term is not happy. It is apt to suggest a covering that can be stripped from the organ it covers, in the way that the kidney capsule can be removed from the surface of that gland. This is certainly not the case with the outer portion of the prostate. The term 'capsule' is also used to describe the covering of a benign new growth from which the growth can be shelled out. In this sense it is used of a pathological product. In addition certain writers have applied the term 'capsule' to the fibrous covering of the prostate. In order to overcome any ambiguity Mr. Shattock has suggested the term 'cortex'. This term seems to adequately express the facts, since the outer non-glandular portion of the prostate is simply a portion of the stroma which is devoid of gland tissue, and is therefore an integral part of the gland. It can no more be separated from the rest of the organ than can the cortex of the kidney from the subjacent parenchyma.

In microscopical preparations of the anterior portion of a transverse horizontal section, the presence of striped muscle fibre can, as a rule, be easily demonstrated (see p. 34, and Fig. 9). Outside the 'cortex' lies a covering of fibrous tissue. This will be referred to as the 'fibrous sheath' of the prostate. Embedded in it on the anterior and antero-lateral surfaces can be seen the prostatic plexus of veins, and near the posterior lateral angles, in addition, bundles of nerves containing medullated and non-medullated fibres as well as ganglion cells.

If a section, similar to that just described but taken nearer the bladder, be examined, some points of difference are to be noticed. The urethra is star-shaped. The uterus masculinus is not to be seen, and the ejaculatory ducts occupy a position almost at the posterior surface of the gland. Sometimes on either side of these, if the section is taken high enough, can be seen the

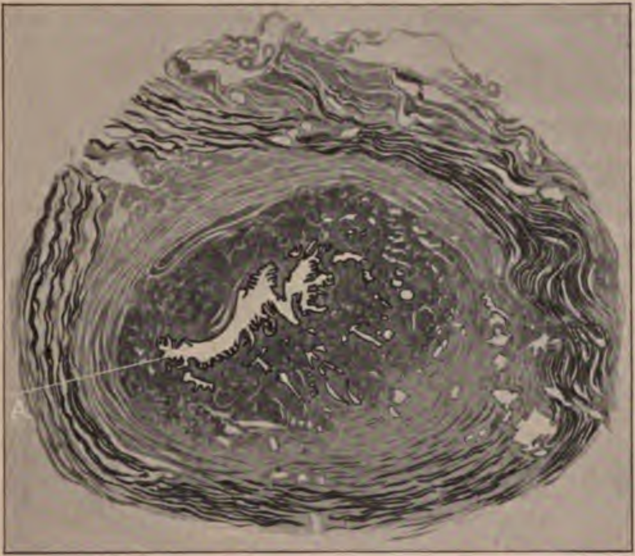

FIG. 5. A section of the inferior extremity of the prostate taken at right angles to the urethra. In the centre lies the urethra; the wall is much plicated. Outside the canal is an area composed of plane muscle fibre, here cut in cross section. Between the fibres are numerous glandular alveoli. Outside the longitudinal coat is the circular unstriped coat. Most externally is a layer of striped muscle fibre. This muscle is continued up on to the anterior surface of the prostate, and distally becomes continuous with the constrictor urethrae muscle. The extremity of the line A lies in the urethra.

vesiculae seminales cut transversely. The area lying between these canals behind and the urethra in front is filled without exception, in all the sections that I have examined, with gland tissue. The anterior part of the prostate at this level is, as a rule, less richly supplied with gland tissue than at the level described in the last paragraph, or in other words, near the bladder the gland tissue is mostly found on a plane posterior to the urethra.

If another similar section be taken towards the apex of the organ, it will be found that the area of the gland thus cut is much diminished in size. The urethra, again situated towards the anterior part, is star-shaped, due to corrugation of its walls. The anterior part of the organ is usually fibrous, and the gland tissue only found behind the urethral canal. The striated muscle before mentioned is, as a rule, well marked.

Fig. 5 shows another section taken at the extreme apex of the organ. The mucous membrane of the urethra is extraordinarily plicated, and presents many crypts and recesses. Outside the mucous lining lies a well-developed longitudinal unstriped muscle layer, and embedded in this are numerous gland spaces. Outside the longitudinal layer lies another circular layer of unstriped muscle. Most externally is a well-marked layer of striped muscle. This is the innermost extremity of the constrictor urethrae, and is continuous towards the bladder with Henle's muscle.

### THE RELATION OF THE PROSTATE TO THE BLADDER

*The internal meatus.* The junction of the prostate and the bladder forms a groove which is most marked on the lateral and posterior surfaces. The coats of the bladder consist mainly of an outer longitudinal and an inner circular layer. In the outer longitudinal layer the fibres are but loosely connected together, and, passing down on all sides from the top of the bladder, become inserted into the prostate at the bottom of the vesico-prostatic groove. In microscopic sections of this region they can be easily traced and seem to end abruptly, their attachment to the prostate not being particularly intimate. The circular coat of the bladder is, like that of the external or longitudinal coat,

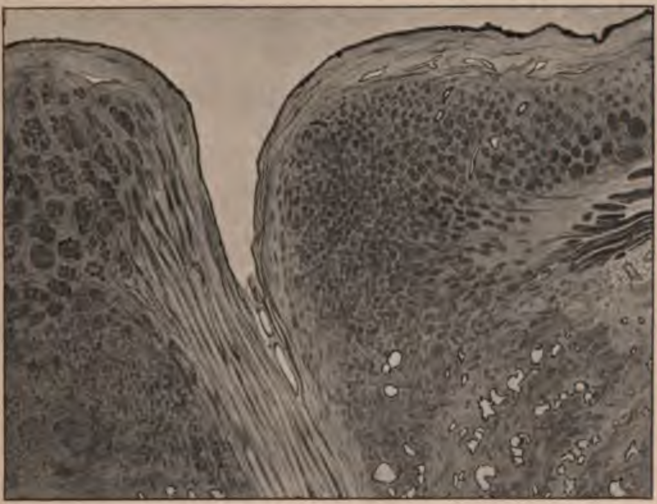

FIG. 6. A median sagittal section through the internal meatus. Posteriorly is seen the sphincter vesicae, the fibres of which are cut in cross section. The muscle bundles are near together. Anteriorly similar muscle bundles are seen, but more openly spaced. The mucous and sub-mucous lining of the bladder are indicated. The sub-mucous coat rapidly decreases in thickness within the internal meatus. Surrounding the urethra are longitudinally running muscle fibres. Towards the bottom of the drawing, glandular tissue can be seen to gradually approach the urethra. To the right of the drawing and below and externally to the sphincter, is seen the longitudinal coat of the bladder at its insertion into the prostate.

of open structure over the greater part of its extent, but over the trigonal area it undergoes a sudden change. The fibres become more closely bound together, and the coat is altogether denser than elsewhere. This is partly due to the fact that there is less connective tissue between the bundles, and partly that other fibres are present whose direction is not altogether circular; microscopic sections of this part often show a dense felt-like mass of fibres. The extent to which this trigone muscle is developed varies very much in different bladders, and to such an extent is it developed in some that it forms a more or less rigid plaque let into the bladder wall. In front and at the sides of the bladder, that is, in the area not occupied by the trigone, the fibres are still separated by a fair amount of areolar tissue, so that the inner coat is by no means so dense as in the trigonal area.

If a median sagittal section is now made through the internal meatus, and examined with a very low power, this area can be more minutely studied. In front and behind the meatus is seen the so-called sphincter vesicae, the bundles of which are cut in transverse section. Behind—that is, under the uvula vesicae—the bundles are seen to be close together. The amount of muscular tissue varies within wide limits, and is occasionally so developed under the uvula as to give rise to a suspicion of a tumour. On the anterior aspect of the urethra there are still muscle bundles cut in cross-section, but they are separated by a very considerable amount of areolar tissue. Nearer the mucous membrane of the urethra on both sides of the meatus, is a variable amount of longitudinal muscle-fibre. Posteriorly it is not as a rule well marked, but anteriorly it is a noticeable feature, longitudinal fibres often running in between those having a circular direction. Immediately inside these longitudinal fibres is a certain amount of sub-mucous areolar tissue, but this quickly ceases before any great distance from the internal meatus, measured down the urethra, is reached. Over-lying this, and forming a lining membrane of the canal is seen the epithelium of the bladder.

A section taken at right angles to the urethra at this level presents appearances which one would have expected from the description of the vertical section (see Fig. 7). Behind, there is a well-marked, circumferentially running mass of muscle-tissue. Traced round towards the anterior part of the urethra, the circumferential direction of the fibres is more or less lost, and we have an area in which the fibres run in every direction, some being cut transversely, some longitudinally, and some obliquely. Inside this muscular layer is sub-mucous areolar tissue, containing many spaces which apparently belong to the lymphatic system. Lining the urethra, here star-shaped on cross-section, is seen its mucous membrane. The internal longitudinal fibres which lie under the mucous membrane at the internal meatus, are continued upwards over the trigone muscle. Some run to the opening of the ureters, others, lying more laterally, pass to the outer side of these openings, and are continued up on to the fundus of the bladder (see Fig. 11). These fibres constitute the internal longitudinal or sub-mucous layer of the bladder.

*The relations of the muscle fibres of the bladder to the prostate.* In order to study more particularly the relation of the bladder wall to the prostate, it is necessary to make several sections through the organ transverse to the axis of the urethra. In such a section made at right angles to the urethra and passing through the extreme uppermost part of the prostate, the following characteristics are seen. In the centre is the urethra, corrugated in outline. Immediately outside the urethra is an area which varies in different specimens. In some the urethra is surrounded by sub-mucous tissue presenting numerous spaces, which, as before mentioned, apparently belong to the lymphatic system. In other specimens this tissue is very little marked, and its place is taken by muscle cut in cross-section, which indicates that this muscle is passing in a direction parallel with that of the urethra. Outside this area at the sides and posteriorly are seen circumferential fibres. In front the direction of these fibres is not so definitely circular, and

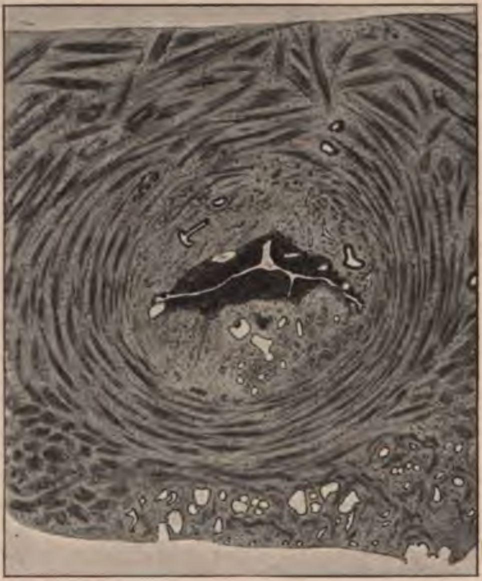

FIG. 7. A section taken at right angles to the urethra and just below the internal meatus. Centrally lies the urethra, the sub-mucous coat of which is infiltrated with small round cells. The sub-mucous coat is well marked, and in this layer a few internal longitudinal muscle fibres are seen lying anteriorly to the urethra. In the sub-mucous layer are many spaces—probably lymph channels. More externally lies the circular coat, the fibres of which are somewhat separated by prostatic stroma. In front, that is to the bottom of the drawing, the direction of the circular fibres is less definitely circular. Behind and outside the circular coat some prostatic gland tubules are to be seen.

they seem to dip in and out of the section. Further away from the urethra in a posterior direction, we find prostatic stroma and gland tissue (see Fig. 7). From this it will be seen that there is a very appreciable interval between the urethral canal and the prostatic gland tissue. In a similar section taken lower down the urethra, the fibres in the circular layer are more widely spaced and the intervals filled with prostatic stroma. On the posterior aspect of the urethra, between some of the circular fibres are seen a few gland spaces. In other words, the prostatic gland tissue has approached the urethra. If another section be taken still further from the bladder, the

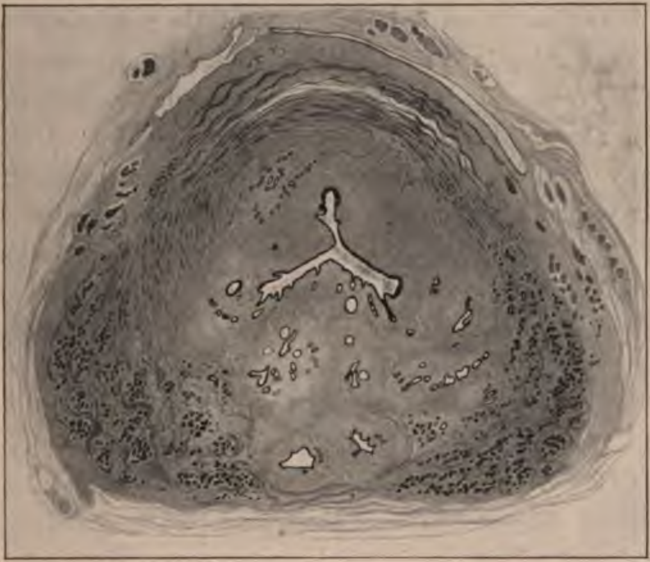

FIG. 8. A transverse section of a young prostate taken at the commencement of the veru montanum. The circular fibres derived from the muscle coat of the bladder are seen to be well marked in front, but to be broken up among the gland tissue posteriorly. At the posterior border of the specimen are the ejaculatory ducts surrounded by a definite investment. The wavy fibres in the anterior part of the section are striated muscle fibre. The gland tissue is scanty, and collected for the most part at the postero-lateral angles of the gland. The long spaces in the tissue to the front of the section are sections of veins. Numerous plane muscle bundles are to be seen in the fascial covering of the organ on its anterior and lateral aspects.

urethra will be seen to be triradiate, owing to the section passing through the commencement of the veru montanum. Underneath the mucous membrane may be seen a few longitudinal fibres, but their presence is by no means constant, and the tissue about them is largely that of the prostatic stroma, the fibres passing in every direction. Outside this area we find circularly running fibres, but in much less abundance than in the section above. In this layer, mostly composed of prostatic stroma and only showing occasionally circularly running fibres, lie masses of gland tissue which come up very close to the mucous membrane of the urethra. A section still lower shows the gland tissue close by under the urethra, and into the urethra can be seen to enter various gland ducts (Fig. 9). The section is almost entirely filled with prostatic stroma and gland tissue, there being very little evidence of any circularly running fibres. From this it will be seen that the fibres of the so-called sphincter of the bladder have dipped down and gradually mingled with the stroma and gland tissue of the prostate, that the sub-mucous layer, found within the internal meatus, has disappeared, that the mucous membrane has come to lie on the prostatic stroma with intervention of a few longitudinal muscle fibres, and that the gland tissue, formerly well outside the urethra, has taken up a position almost immediately under it.

In a certain number of cases, while the circular muscle fibre is still well marked and forming a very definite barrier between the gland tissue behind and the urethra in front, there can be seen lying close under the mucous membrane undoubted prostatic glandular alveoli. As will be pointed out later on, these glandular alveoli may possibly give rise to the small adenomatous tumours situated just within the internal meatus (see Fig. 39).

From the above description it is evident that the bladder wall and the prostate gland are inextricably mingled, and that there is no definite point where it is possible to say that one ends and the other begins.

### STRUCTURE OF THE URETHRA

The length of the prostatic urethra is about 30 mm. (1¼ in.). The diameter near the bladder is about 8 mm., and is somewhat increased lower down so that it measures about 11 mm. Its axis is almost vertical, but the lower part as a rule has a forward direction, the change in axis between the upper and lower parts corresponding more or less accurately to the point at which the ejaculatory ducts open into this canal. The shape of the internal meatus as seen from the bladder is either a dimple, or small crescent. The upper part of the prostatic urethra is roughly star-shaped in transverse section. At the commencement of the veru montanum it is either crescentic with the horns backwards, or triradiate. At the summit of the veru montanum it forms a well-marked crescent. Towards the apex of the gland it again becomes star-shaped, owing to the longitudinal folds into which its wall is thrown. In the upper part of the urethra there is a various amount of longitudinally running muscle which is on the whole most marked in front, but the longitudinal muscle above the opening of the ejaculatory ducts is so patchy and inconstant in its arrangement that it can hardly be regarded as forming a longitudinal coat. Below the opening of the ejaculatory ducts the longitudinal muscle becomes very well marked, and under the microscope shows strong and closely set strands surrounding the whole urethra (Fig. 5). Near the internal meatus the sphincter muscle is continued down into the prostate and forms what may be termed a circular coat to the urethra, but owing to the breaking up of these fibres amongst the prostatic stroma this coat is only recognizable as such for a little distance from the internal meatus. In nearly all prostates there is to be found a very distinct area lining the urethra which is devoid of gland tissue, and this above the opening of the ejaculatory ducts is largely formed of prostatic stroma, but below is composed of longitudinal muscle. If the prostatic urethra be laid open by an incision along its anterior surface, it is seen to be marked near the internal meatus by

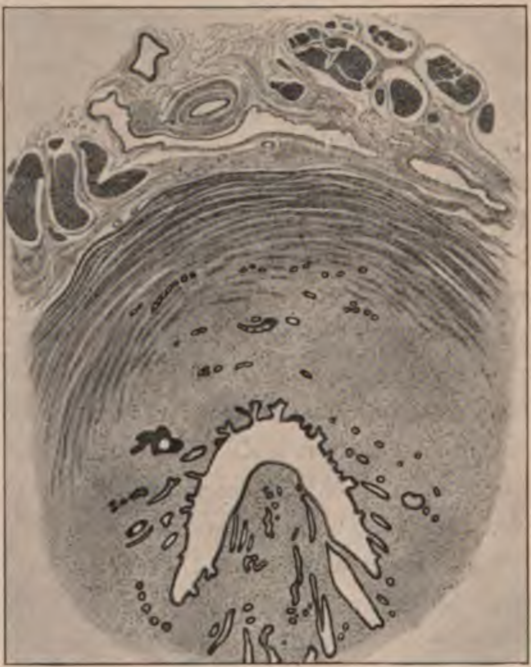

FIG. 9. A transverse section of the prostrate of a young child taken through the veru montanum. Gland ducts enter the urethra on every side. There is some scattered glandular tissue in the mid-line anteriorly to the urethra. The circularly running fibres shown in front of the urethra, belong to the striated muscle fibre found on the anterior surface of the prostate. At the top of the drawing and lying in the fascial sheath are venous spaces and plane muscle fibres (pubo-prostatic ligaments).

numerous longitudinal striae, and one of these, becoming more marked than its fellows, forms the veru montanum, and reaches the maximum point of its projection above the floor of the urethra above the level of the entrance of the ejaculatory ducts, when it quickly subsides into the plane of the urethral floor.

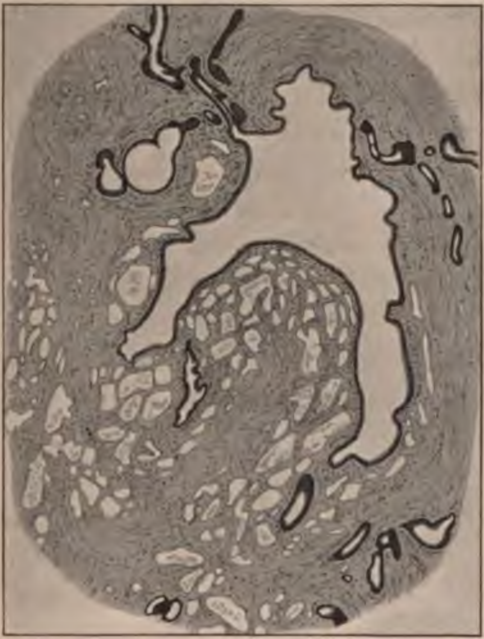

Fig. 10. A transverse section through a young prostate about the middle of the veru montanum. The section shows gland ducts entering the anterior wall of the urethra, also numerous vascular spaces in the substance of the veru montanum.

On its lower slope opens the uterus masculinus, on the lips of which are situated the openings of the ejaculatory ducts.

The veru montanum, which is about 17 mm. long and about 4 mm. high, is composed of fibro-muscular stroma, but in its substance can be seen large blood-containing spaces. In addition to this it is largely supplied with gland tissue, and on its sides may often be seen the openings of the prostatic glands.

Among the most striking features of the prostatic urethra, when cut in cross-section and examined microscopically, are the almost innumerable pits and recesses which it presents, and which suggest the impossibility of ridding this canal of bacterial infection by means of local applications. The number and complexity of these crypts increase from above downwards. Near the internal meatus the mucous membrane presents a fairly even surface. Further down the surface is broken by the openings of the prostatic ducts, but it is near the apex that the condition is most marked, and is due at this point rather to plication of the urethral wall than to the presence of gland ducts.

*The epithelium of the urethra.* This is of columnar variety. It consists of a layer of short columnar cells lining the lumen, and of a deeper layer of small polyhedral cells, some of which occupy the spaces between the outer extremities of the columnar cells. It resembles that of the bladder, except for the absence of the flattened superficial cells. Near the bladder the mucous lining rests on an areolar tissue basis, but towards the middle of the prostate this disappears, and the epithelium rests on the stroma of the gland or on the longitudinal muscle layer.

### THE EJACULATORY DUCTS

These ducts are formed on the surface of the prostate or just within its substance, by the fusion of the narrowed portions of the vasa deferentia and vesiculae seminales. The two ducts soon lie side by side, and run forwards and downwards for about 25 mm., to enter the urethra by piercing the lips of the prostatic utricle. The calibre of the ducts usually diminishes until it reaches a diameter of about ·5 mm. (Quain); on the other hand, it may be considerably larger than this even near the urethra.

At first the ducts are surrounded with a fibrous envelope, and when this ceases they lie embedded in the stroma, the fibres of which, for a short distance from the surface, arrange themselves circularly around the canals. The walls of the ducts are very thin, and are said to contain an outer circular and inner longitudinal muscle layer. These layers are very difficult to demonstrate, and at a short distance from the surface the epithelium lining the ducts lies directly on the stroma of the prostate. The epithelial coat is of the columnar type, and is thrown into numerous folds. On account of the absence of proper walls and the crenation of the epithelial lining, it is often difficult to distinguish an ejaculatory duct from those of the prostatic glands.

*The third lobe.* There is no such thing as a middle lobe of the prostate; the term is altogether misleading. The 'third lobe' is described as that part of the prostate which lies between the ejaculatory ducts behind and the floor of the urethra in front. It has been shown when speaking of the appearances presented on transverse section of the organ, that this particular part of the gland is directly continuous with the rest. It therefore follows that the 'third lobe' has no lateral boundaries, while the anterior boundary has only the width of the floor of the urethra, and the posterior that of the combined diameters of the ejaculatory ducts. Such a lobe is not worth a name.

The ejaculatory ducts pierce the prostate as a knitting needle may be made to pierce an apple from rind to core.

### THE FASCIAL SHEATH OF THE PROSTATE

The anterior fibres of the levator ani pass directly backwards towards the rectum from their attachment to the back of the pubes, an interval being left between the muscles of the opposite sides. This interval is bridged by the so-called posterior layer of the triangular ligament, a fascia filling the space between the rami of the pubes and continuous with the obturator fascia, and at the inner margin of the levator ani with the anal, and with that fascia which is described as the vesical part of the recto-vesical fascia. This area of fusion of the fasciae (triangular ligament) and the levator ani form the pelvic floor in the neighbourhood of the prostate. The pelvic floor is of basin form, consequently both the anterior and the lateral walls slope to the lowest point, which is situated at the recto-urethral angle (top of perineal body).

As has been stated above, the most anterior fibres of the two levator ani muscles running directly backwards do not meet until the central point of the perineum, and in the space thus left the prostate rests by its apex on the so-called triangular ligament, that is, on the floor of the pelvic basin at a point slightly anterior to its deepest part. Some of the anterior fibres of the levator ani are actually inserted into the prostate. Although the axis of the prostate is vertical, yet, owing to the inclination of the pelvic floor and to the rapid increase in the horizontal diameters of the gland, there is little space left between the exterior of the organ and the pelvic walls, either in front or at the sides. Behind there is a greater space between the gland and the pelvic wall, which space is filled by the rectum, this latter being in close contact with the posterior surface of the prostate. As is the case with all other structures of the body, this organ is connected with its neighbours by planes of areolar tissue. In front it is connected with the triangular ligament, on the sides with the levator ani, and behind with the rectum. Coronal and sagittal sections of the pelvis show how little space intervenes between the organ and the surrounding structures.

The connective tissue, although simply playing the part of a packing, is usually described as consisting of definite sheets to which different names have been given. This is likely to lead

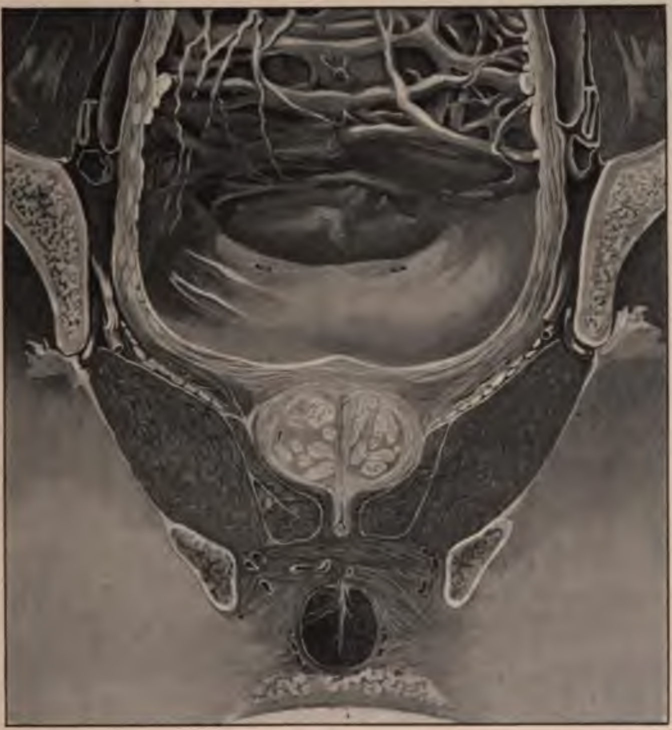

FIG. 11. A coronal section of the pelvis taken immediately behind the internal meatus. Two bristles have been introduced into the ureters. The gland tissue towards the centre of the prostate shows early adenomatous change. The walls of the bladder are fasciculated, and the organ itself is dilated. Closely applied to the external surface of the prostate lie the levator ani muscles, and outside these the obturator internus muscles. The so-called splitting of the pelvic fascia is seen. In the angle between the bladder and the prostate, the vessels of the prostatic plexus are shown cut in cross-section. Between the latter and the obturator internus muscle lies a layer of fat. Below the opening of the right ureter are some obliquely running muscle bundles, which apparently belong to those that are described as passing from the internal meatus to the ureteric openings. These fibres can be traced up, and are seen to run in a longitudinal direction, internal to the hypertrophied bundles of the circular bladder coat. It is to be noted, that the levator ani muscles are in actual contact with the sides of the prostate separated by some areolar tissue only; there is no appearance of a reflection of the fascia from the muscle on to the surface of the gland.

to erroneous ideas, since, although able to resist considerable pressure when this is applied at right angles to its surface, it is capable of being split into innumerable planes when the cleavage is performed parallel to its surface. It is usual to describe the fascia covering the levator ani as being reflected off this muscle and on to the prostate, to form the sheath of this organ. As a matter of fact, the levator ani muscles are in close apposition to the sides of the gland, and the interval between the two is filled with a many-planed areolar tissue, in which are embedded some of the veins of the prostatic plexus. Between the triangular ligament on the one side, and the anterior surface of the prostate on the other, a similar arrangement is found, and in this fascia is embedded the anterior part of the prostatic plexus. Between the rectum and the prostate a delicate fascia extends down as far as the apex of the perineal body at the recto-urethral angle. The fascial space between the prostate and the rectum is remarkable in two ways. Firstly, on account of the absence of fat, in which particular it differs from that surrounding the prostate in other quarters, and secondly, for the ease with which the planes can be separated with the finger. In other words, this is probably a lymph space like that below the occipito-frontalis or behind the pharynx. It is into this space that the finger penetrates in perineal prostatectomy, vesiculectomy, or excision of the rectum, after the division of the recto-urethral muscle has been accomplished. It is held by Denonvilliers that this space is formed by a fusion of the two layers of peritoneum, which in the foetus dip down to the primary perineum, that is to the apex of the perineal body. Towards the upper limit of the postero-lateral border of the prostate, the vessels, nerves, and ureters pass out of the pelvic wall and are embedded in areolar tissue. The peritoneum is somewhat raised by these structures, and to the fold thus made the name sacro-genital has been given. Above the upper limit of the levator ani muscles, the areolar tissue surrounding the prostate passes insensibly into the sub-peritoneal tissue covering the bladder and the rest of the pelvic contents.

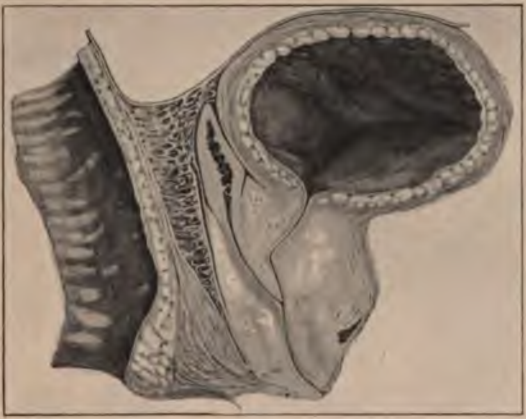

FIG. 12. A median sagittal section of the bladder, prostate, and rectum. The rectum has been pulled away from the bladder and prostate, thus showing the delicate connective tissue lying between them. The condensation of this tissue on the rectum, prostate, and vesiculae is indicated. The peritoneum passes from the rectum on to the bladder just above the upper limit of the vesiculae seminales. The cleft between the prostate and rectum extends almost to the bottom of the drawing, ceasing at the upper extremity of the perineal body. The confusion of the different layers in the mid-line on the anterior surface of the prostate can be seen. The prostate is slightly enlarged, and the antero-posterior distortion of the urethra is commencing.

The usual description of the arrangements of the pelvic fascia is due to an artificial cleavage of the fascial planes. If the abdomen is opened, and the peritoneum divided along the pelvic brim, it is possible with the aid of the finger to strip the serous coat off the underlying structures, to reflect it towards the mid-line, leaving it only attached to the summit and fundus of the bladder, and to the recto-vesical pouch and the anterior wall of the rectum. The finger can now be made to enter the fascia occupying the space between the prostate and the back of the symphysis and the triangular ligament. It can then be carried along both sides of the prostate, separating the levator ani from the sides of this organ. An artificial space or trough is thus

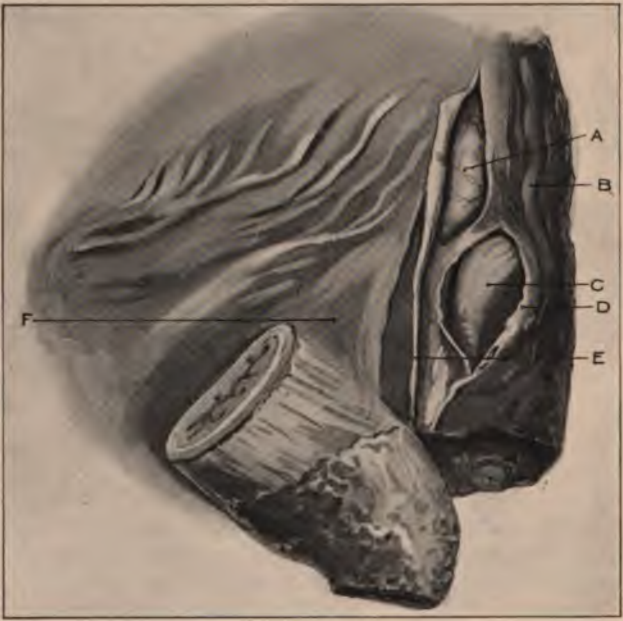

FIG. 13. The prostate and rectum viewed from the side. A, vesiculae seminales. B, a vein of the plexus running upwards to the ureter. C, the postero-lateral angle of the prostate exposed by incising and raising the fascial covering. Between the vesicula seminalis and the prostate is a portion of the fascia adherent to the bottom of the vesico-prostatic groove. D, the edge of the fascial covering so raised. E, a plane of fascia passing from the prostate over the vesiculae and reaching the bladder. F, the peritoneum. E and D are different planes of the same fascia, the distinction is due to dissection; they are both really parts of the fascia between bladder, prostate, and rectum.

created, lined by the fascia on both surfaces. On one side the wall is formed by the prostate, and on the other by the triangular ligament, rami of the pubes, and the levator ani. It will now appear as if the fascia lining the superior surface of the levator ani was reflected off this structure on to the surface of the prostate. If an incision be now made through the peritoneum at the bottom of Douglas's pouch, the finger can be inserted into the fascial space between the prostate and the rectum. This space is separated from the above-mentioned trough-like space by the passage outwards of the vessels, nerves, and ureter from the postero-lateral border of the prostate. The fascia surrounding these structures, and usually called the rectal fascia, will now have the appearance of passing at a right angle from the surface of the levator ani, to gain the posterior surface of the prostate.

If the urethra, ureters, vessels, and nerves are now divided, the prostate and bladder can be removed from the body, and the relation of the prostate to its fibrous covering more closely studied. There is no hard and fast line between the organ proper and its fascial sheath, and in microscopic sections taken of the outer edge of the organ it is not easy to say where the prostate ends and sheath begins. If an incision is made down to the cortex of the gland, and a blunt instrument introduced, it is possible to raise this many-layered sheath from the cortex over the whole surface of the gland except at the following points :—

1. The apex.
2. The mid-line of the anterior surface.
3. The vesico-prostatic groove.

At the apex the fascial sheath blends both with the cortex of the gland and with the triangular ligament. The fusion of the fascia and the prostate in the mid-line in front is remarkable, and in sections of the gland taken at right angles to the urethra, the idea of scar tissue is often suggested. At this point, the fibrous tissue of the sheath with its plain muscle fibre, the striped muscle fibre already described, and the prostatic tissue, both stroma and gland, are inextricably fused together. This fusion of layers is immediately in front of the so-called anterior commissure, and is in fact directly continuous with it. The anterior commissure of the prostate indicates the fusion of the two lateral masses of the gland in front of the urethra, and it seems not improbable that this fusion or confusion of different structures is brought about by that process.

The attachment of the fascial sheath to the bottom of the vesico-prostatic groove takes place on every side of the organ. Laterally this arrangement serves to bind the prostatic plexus in place, the deeper layers of the sheath passing beneath the veins and the superficial ones over them. On the posterior surface the fascia has a similar relation to the vasa deferentia and vesiculae seminales, forming an envelope for them, and binding them into the groove and on to the base of the bladder. The inseparability of the gland and its sheath at certain definite points is of great importance, as will appear when the feasibility of total removal of the organ is discussed.

### VESSELS

The arterial supply of the prostate is derived from branches of the vesical, haemorrhoidal, and internal pudic arteries. They are mostly seen on the postero-lateral aspect of the organ. Only small twigs penetrate the gland, which is not a vascular organ.

From a surgical point of view the veins are much more important than the arteries. The dorsal vein of the penis enters the pelvis through the subpubic space and reaches the anterior surface of the prostate, where it lies between the layers of the fibrous sheath of the prostate. Here it divides into two branches which diverge towards the sides of the organ. Each branch is joined by communicating vessels from the internal pudic and obturator veins. A plexus is thus formed on the sides of the prostate, the mid-line being almost devoid of veins. Passing upwards and backwards the two halves of the plexus enter the vesico-prostatic groove, and are here joined by vessels from the vesical plexus. Continuing still further backwards the plexuses reach the postero-lateral border of the prostate, and then incline upwards to reach the point at which the ureter penetrates the bladder wall. At this spot the veins come into contact with the vesiculae seminales, and receive small branches from their exterior. They then turn outwards to reach the lateral wall (levator ani) of the pelvis, and empty into the internal iliac veins.

The prostatic plexus has been described as V, Y, or H shaped, and although in different cases these letters may represent more or less accurately the shape pertaining in the particular instance, yet the arrangement is so inconstant that it does not seem helpful to ascribe any particular form to the plexus. The size of the individual constituents of the plexus varies within wide limits. In the young the vessels are comparatively small, but in later life they are often of formidable size and engorged with blood. The vessels lie between the layers of the fibrous sheath of the prostate, and are therefore firmly bound on to its external surface, especially along the vesico-prostatic groove.

### LYMPHATICS OF THE PROSTATE

The lymphatics (Leaf, translating Poirier and Cuneo) start as a fine network surrounding the acini. These combine to form larger vessels, which find their way to the surface of the organ where the collecting trunks are formed. These are four in number.

1. The posterior starts from the back of the organ and

ascends between the vesiculae seminales, and ends in the external iliac glands.

2. Another starts from the same surface, accompanies the prostatic artery, and ends in the hypogastric group.

3. Two or three smaller trunks also start from the posterior surface, pass backwards and downwards, to end in the glands of the promontory and of the sacrum.

4. The efferent trunk, from the anterior surface of the organ unites with the vessels from the membranous urethra, accompanies the artery of the corpus spongiosum and so gains the internal pudic artery, and terminates in the hypogastric group.

### NERVES

The nerves of the prostate are derived from the hypogastric and pelvic plexuses, and are therefore connected with the second, third, and fourth sacral spinal nerves. The branches, which are of considerable size, contain ganglion cells, medullated and non-medullated fibres. They pass with the prostatic vessels from the surface of the levator ani to the postero-lateral border of the organ. After supplying the prostate and the vesiculae seminales the plexus is continued on, and is distributed along with branches from the pudic nerve, to the erectile tissue of the penis.

### HENLE'S MUSCLE

Allusion has been made above to the presence of striated muscle fibre on the anterior surface of the prostate. This muscle fibre is found most strongly developed in the young organ (Fig. 17). It is most marked near the apex, but reaches up towards the bladder to a very variable extent. Transversely it extends outwards to the postero-lateral angle of the organ. It is intimately blended with, and cannot be raised from, the gland, and in addition to this its fibres are found well below the surface of the organ, so that at a little distance from the

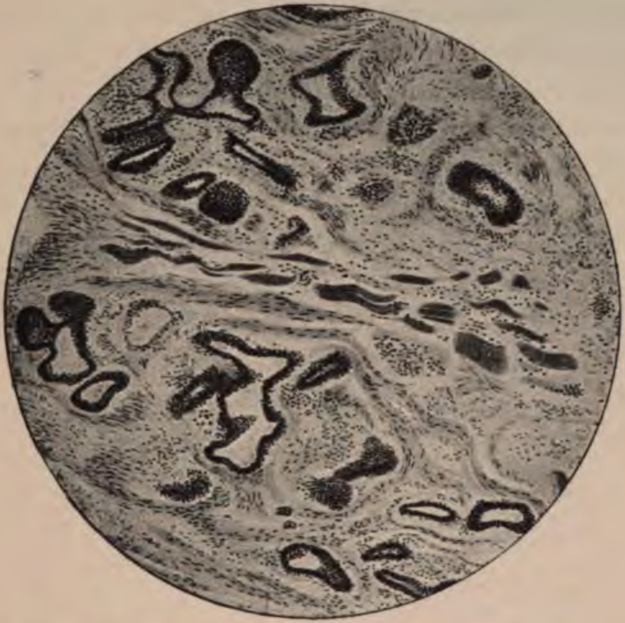

Fig. 14. A microscopic section of the anterior part of the prostate of a youth aged eighteen years. In the centre of the field are seen striped muscle fibres lying between the glandular alveoli.

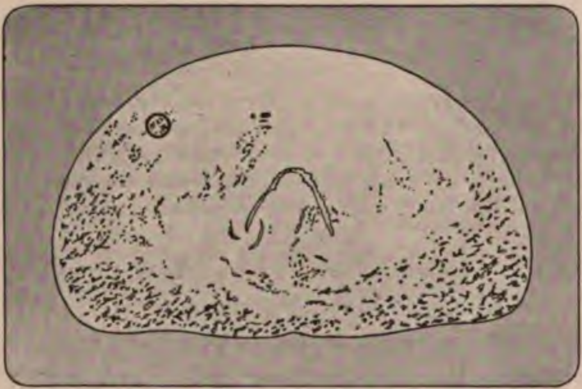

Fig. 15.

surface fibrous tissue, striated muscle, plane muscle, and glandular alveoli are closely intermingled.

The depth at which its fibres may still be found is indicated by the ring seen in Fig. 14. This ring marks a microscopic field (Fig. 13) where striated muscle fibre was seen to lie between alveoli.

Traced downwards this muscle appears to be continuous with the constrictor urethrae.

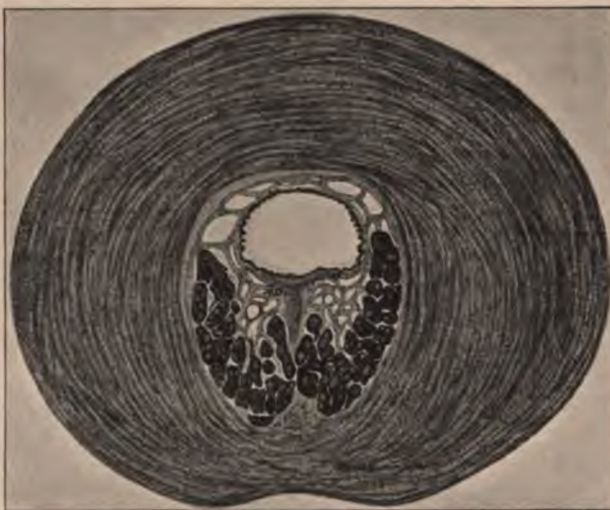

FIG. 16. A transverse section of the prostate of a sheep. The dark mass immediately behind and outside the urethra is the prostate gland. The urethra and prostate are contained in a thick envelope of striated muscle, which is apparently the homologue of the striated muscle found on the anterior surface of the human prostate.

In man this muscle does not seem to have any special function. It corresponds apparently to a strong striated muscle which completely surrounds the prostate and urethra in some animals. The extent to which it is developed is well shown in Fig. 16, which is a transverse section of a sheep's prostatic urethra.

### THE DEVELOPMENT, GROWTH, AND COMPARATIVE ANATOMY

Keibel (*Archiv für Anat. und Physiol.*, 1896) has shown that the glandular elements of the prostate arise from the urethra above the openings of the Wolffian and Müllerian ducts. The prostate is therefore, developmently, an entirely urinary organ. This is remarkable, since experimental pathology would seem to show that it is a genital gland. The stroma of the organ takes its origin from the mesoblastic tissue about the Wolffian and Müllerian ducts, and from the musculature of the urethra.

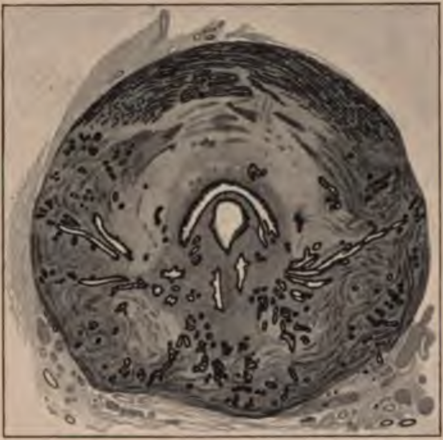

FIG. 17. A transverse section of a prostate of a six months' foetus. The striated muscle on the anterior surface of the organ is well marked.

At the sixth month of intra-uterine life the prostate forms a small, compact, sub-globular mass, and shows very little evidence of its multi-lobular origin. Tranverse sections taken near the upper limit of the uterus masculinus show for the most past fibro-muscular tissue. The urethra, as seen in section, is crescentic. Within the horns lies the uterus masculinus, and immediately behind it the two ejaculatory ducts. The gland tissue, which lies almost entirely behind the plane of the urethra, is but sparsely represented, because the tubules have not finished their branching. In front the striated muscle of Henle forms a very conspicuous band. A higher magnification shows that the urethra presents many crypts, and the openings of the prostatic glands are seen at the bottom of the crescentic horns.

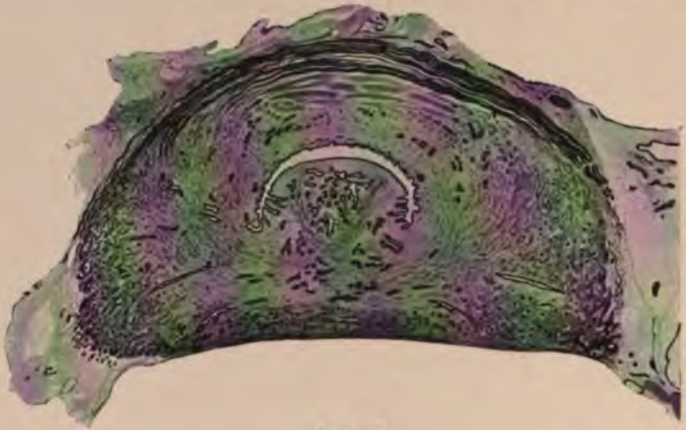

FIG. 18.

At eight years (Fig. 18) the organ has increased somewhat in size, and taken on more or less the adult form. Having regard to its increase in size, there does not appear any increase in the glandular elements. Henle's muscle still forms a well-marked band on the front of the organ. At eighteen years the organ has increased in size, but the glandular elements are but scantily developed. Between twenty and twenty-five years the prostate is fully developed and becomes an essentially glandular organ.

The comparative anatomy is, for the most part, a repetition of the stages seen in the development of the organ. According to Richardson, it is absent in the sloth and is met with in its most simple form in marsupials, in which it is represented by a thickening of the mucous membrane of the urethra. In guinea pigs it consists of a series of caecal tubes arranged radially to the urethra. In the mole the tubules are more complex, and in the breeding season form a very conspicuous mass. In the sheep it forms a bilateral elongated mass of gland tissue, lying behind the urethra and surrounded by a greatly developed striated muscle layer. In the rabbit it is composed of five lobes, which lie in juxta-position to the urethra and to the uterus masculinus. In the dog, as in man, it forms a compact mass, wrapped round and intimately adherent to the urethra, enclosing in this enveloping process the terminations of the Wolffian and Müllerian ducts. In all animals it is connected with the ento-dermal portion of the urethra, from which its glandular elements originate.

# CHAPTER II

## THE EXPERIMENTAL PATHOLOGY AND FUNCTION OF THE GENITAL GLANDS

THE genito-urinary apparatus may be said to consist of the following parts:—

I. Glands.
II. Ducts.
III. Reservoirs.

I. Glands.
  (1) Urinary—The kidney.
  (2) Genital—The testis.
    The prostate.
    The vesiculae seminales.
    Cowper's glands.

II. Ducts.
  (1) Urinary—The ureters and the first part of the prostatic urethra.
  (2) Genital—The vasa deferentia.
  (3) Genito-urinary—The urethra, below the opening of the uterus masculinus.

III. Reservoirs.
  (1) Urinary—The bladder.
  (2) Genital—The expanded portion of the vasa deferentia.
    The vesiculae seminales—(according to the ordinary idea).

### EXPERIMENTAL EVIDENCE OF THE EFFECTS OF CASTRATION

Individuals when born are only potentially of the sex indicated. The sexual apparatus and glands are present, but incompletely developed, and the individual can therefore be described as neuter, and the state of the body infantile. The ultimate test of sex is the possession of a gland producing either spermatozoa or ova. It is well known that the external configuration of the body is apt in this particular to be misleading. It can here be stated that the master organ is the testis, and it is proposed to consider the relation which this organ bears to the others. In 1775, John Hunter made his observation on the hypoplasia, or want of development of the prostate that resulted from castration carried out in youth or in infancy. Time has only confirmed the truth of this fact, and has also shown that ablation of the testis is followed by profound changes in the individual. Removal of the gland in youth has the effect of preventing the development or causing the atrophy of the prostate, the vasa deferentia, the vesiculae seminales, and Cowper's glands. Even the musculature of the genito-urinary canal may be modified by castration. In the castrated sheep, the striated muscle which surrounds the prostate and urethra (see Fig. 16) fails to reach the size and thickness that it does in a perfect adult. The secondary sexual characters also fail to develop at the usual time. It is well known that eunuchs lack the growth of hair on the face and the deep voice of the perfect man. Shattock and Seligmann have also shown that such secondary sexual characters as the horns, in animals of which the male only is horned, fail to appear after castration in the young state.

The knowledge that castration in adult life causes an atrophy of the prostate, seems to rest on the observations of Griffiths, White, and Guyon. Griffiths published his first results in the

*Journal of Anatomy and Physiology*, 1889–90. He stated that the prostate of a dog, a year after it had been castrated as an adult, was to all purposes as atrophied as if the dog had been castrated in youth. In 1893 White confirmed this observation, and Guyon in 1895 repeated the experiments with the same results.

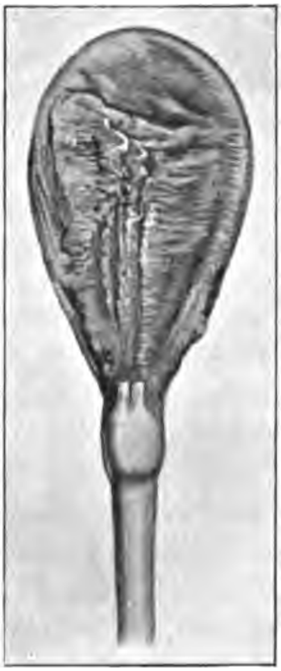

FIG. 19. (Natural size.)

Fig. 19 shows the atrophy produced in the prostate of a dog which was castrated as a puppy, and killed after an interval of eleven months. In order to appreciate the amount of atrophy it should be compared with Fig. 20.

The rate at which atrophy takes place is very remarkable, and Griffiths states that the prostate of an adult dog castrated three weeks previously was small, the tubules reduced in size and number, and the stroma showed hardly a trace of muscle fibre. The author has recently repeated these experiments, and confirmed the atrophy of the glandular tubules.

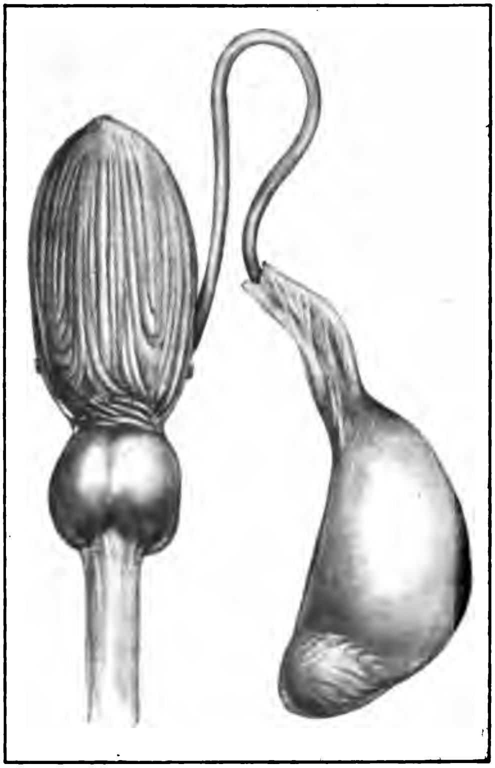

FIG. 20. The bladder, prostate, and testis of a normal dog of the fox terrier breed. The weight of this dog was about the same as that of the dog whose prostate and bladder are shown in Fig. 21. (Natural size.)

When the effects of double castration are being considered, it seems natural to inquire what would be the effect of the removal of one testicle. Since the primary and secondary glands are bilateral, it might be supposed that one testis would control those glands on its own side of the body, and, as a matter of fact, many clinical observers have tried to prove the dependence of one side of the prostate on the integrity of its corresponding testicle. When we turn to the evidence gained by experimental research, however, we find that this is not the case. It is proved that the presence of one testis is enough to maintain the integrity of the whole sexual apparatus, and in addition to this, is amply sufficient to produce all adult male characteristics. As an instance of this, I may quote the following experiment:—

In a puppy the vessels of both spermatic cords were tied, with the exception of the small vessels running on the vasa deferentia. Atrophy of one testis followed, but the opposite testis, although presenting no spermato-genesis, and, though smaller than normal, was found after death (which took place five months later), to possess well developed tubules with well-marked lumina. The vessels on the vas on this side were large and distended with blood, and had evidently, by their increase in size, saved the testis from atrophy. The prostate in this dog was normal in every respect (*Path. Soc. Trans.*, vol. 56, p. 99).

Guyon (*Ninth Surgical Congress*, 1895) found no alteration in the prostate of dogs on whom castration on one side and vasectomy on the other had been performed. The fact that a non-development or congenital absence of one testis and its excretory duct, is accompanied by want of development of the corresponding side of the prostate, does not refute the foregoing observations, since it simply means that one side of the whole apparatus has failed to develop for some reason or other.

The effect of unilateral castration on the vesiculae seminales is also interesting, as the following experiment will show. It must be first stated that the section of the vas has no effect on the growth and nutrition of the testis, but to this we shall return later. In an experiment performed by Shattock and Seligmann, one testis of a sheep was removed and the vas of the other testis was cut in half and ligatured. It was found after death that the prostate and vesiculae seminales were all of full size, and this without asymmetry (*Proceedings of the Royal Society*, vol. 73, p. 52).

### EXPERIMENTAL EVIDENCE OF THE EFFECTS OF DOUBLE VASECTOMY

John Hunter[1] made the observation in the human subject that the testis developed and produced spermatozoa, although there was no connexion between the testis and its excretory canal—the vas. Some years later, in 1825, Astley Cooper performed the following experiment on a dog:—

He divided the vas on one side, and the vessels of the cord on the other. The testis on this latter side sloughed, but the testis of which the vas was divided slightly increased in size. Four years later the dog was killed. The epididymis was found full of spermatozoa, retained by occlusion of the vas. The testis was normal in other respects. The specimen is now in the museum of the Royal College of Surgeons (No. 4289).

Mr. Shattock has recently examined the testis by means of microscopic sections, and finds the tubules to be of normal size and full of epithelial cells which diminish in size towards the centre, where they are intermingled with considerable numbers of spermatozoa. Curling in 1842, and Gosselin again in 1853, confirmed these results. Within the last few years J. Griffiths has once again shown that vasectomy does not hinder the growth of the testis in youth or interfere with the production of spermatozoa in adult life. Further proof of the occurrence of spermatogenesis after vasectomy, in the case of sheep and the fowl, has been supplied by Shattock and Seligmann in their communication to the Royal Society (vol. 73). In this communication it was shown also that after double vasectomy carried out in the young state, the sheep and fowl acquired the full secondary sexual characters: sexual potency, moreover, in the sheep was not

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[1] Hunter's Works, edited by Palmer.

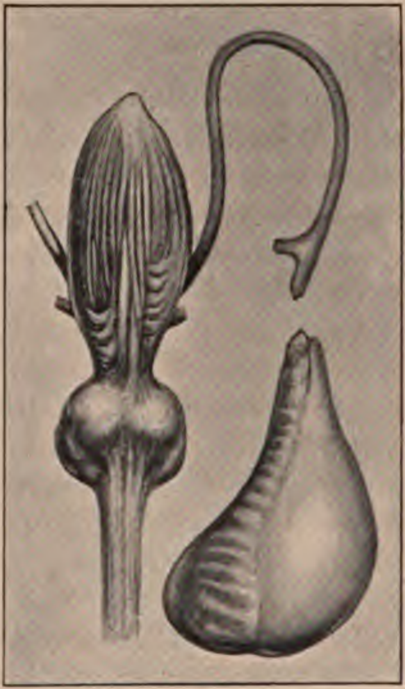

FIG. 21. The bladder, prostate, and one testis of a dog on which double vasectomy was performed five months before the animal was killed. It shows that no atrophy has taken place either in prostate or testes, which have grown to their full size. Spermato-genesis was in active progress in the tubules. (Natural size.)

interfered with. J. W. White, although he recognized the fact that section of the vas did not affect the testis, thought that it might have some effect on the prostate, and performed vasectomy on dogs with the idea of determining its effects on the prostate.

As a result of these experiments, he stated that there was a marked loss of weight and size in the prostate within a short interval after the performance of vasectomy. In fact, his results were the same as those obtained by castration. Guyon, who performed the same experiments about the same time, came to a diametrically opposite result, the intervals between the performance of vasectomy and examination of the prostate varying from two-and-a-half to five months. With an idea of deciding which of these two observers was right, the author performed vasectomy on dogs, with the result that Guyon's observation was

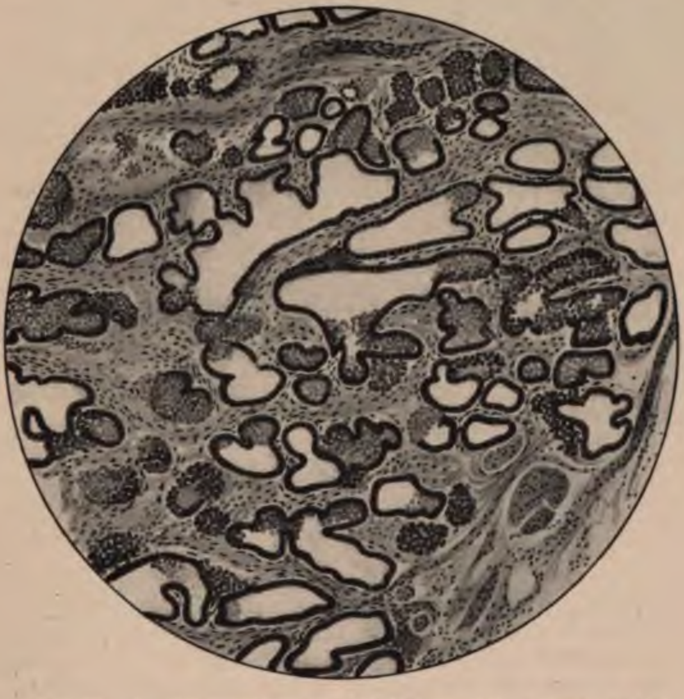

FIG. 22. A microscopic section of the normal prostate of the adult dog, A in Fig. 25.

entirely confirmed. In no single case was there any decrease in size or atrophy of the prostate noticed (*Path. Soc. Trans.*, vol. 56).

If Fig. 20 is compared with Fig. 21, it will be seen that there is no difference in bulk between the prostate of a normal dog and of one on which vasectomy has been per-

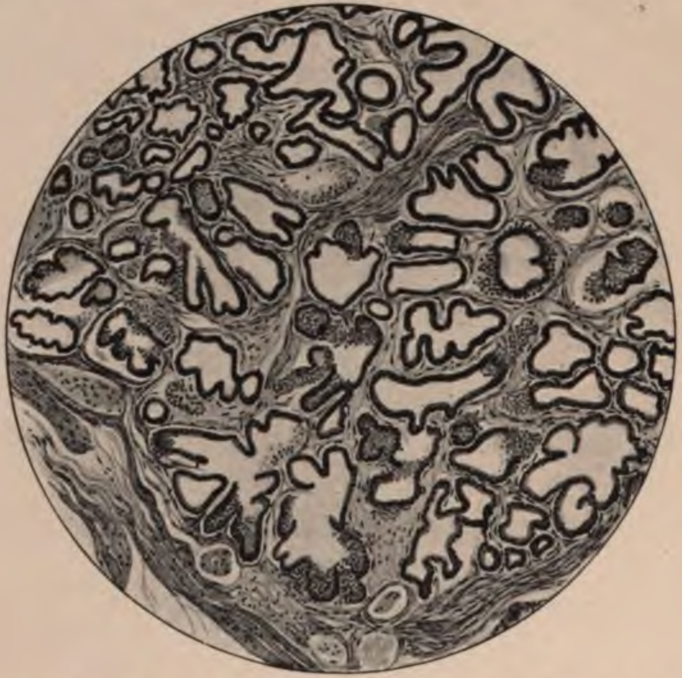

Fig. 23. A microscopic section of the prostate of a dog, aged thirteen months, upon which the operation of double vasectomy was performed when a puppy (c in Fig. 25). Glandular, fibrous, and muscular tissue are present in normal proportions. The size and shape of the glandular alveoli as well as the epithelium are normal. The crowding of the epithelial cells seen in some of the alveoli is due to the section passing through the extremity of those particular glands. If comparison is made with Fig. 22 it will be seen that there is no indication of any departure from the normal. The testes were of the usual size and shape for a dog of the fox terrier type.

formed, and if Figs. 22 and 23 are also compared, it will be seen that there is no change in the microscopic appearances.

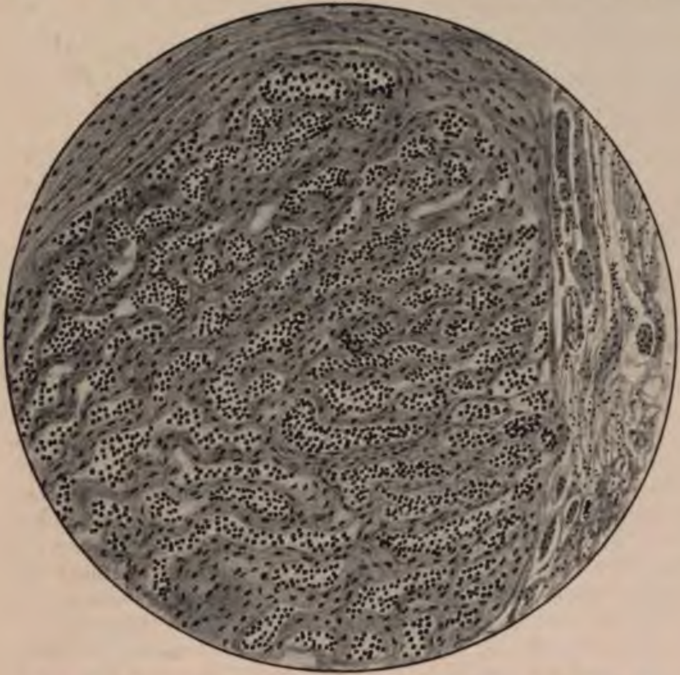

Fig. 24. A microscopic section of the prostate of a dog, the vessels of whose spermatic cords were tied five months previously (B in Fig. 25). Both vasa deferentia were intact. The organ was entirely atrophied, and appeared as a tough, fibrous, fusiform thickening on the urethra. Both testes completely atrophied, and under the microscope showed no signs of glandular tissue. The specimen represents the effect of the interruption of its blood supply on the testis. It can be seen, that the remains of the glandular tissue of the prostate presents itself as narrow tortuous channels, with little or no lumen.

Fig. 25 also shows the appearances to be noted in the prostate of a dog.

A. In the normal state.

B. After ligation of the vessels of the cord.

C. After vasectomy.

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Spangaro (*Lo Sperimentale,* an. 57, F. 3, *Brit. Med. Journ.,* Epitome) found spermatozoa in the testicles of three men aged seventy, sixty-four, and sixty-nine, on whom respectively vasectomy had been performed twelve days, six months, and two and a half years previously.

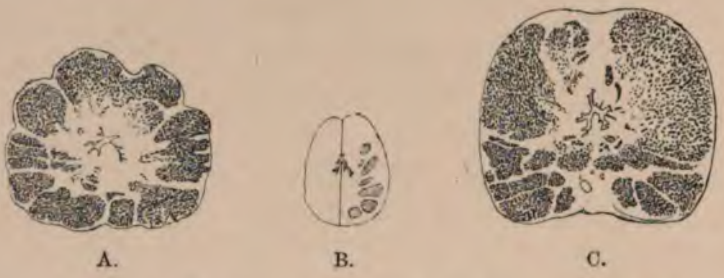

FIG. 25. (A, Normal prostate. B, Atrophic prostate. C, Prostate after a double vasectomy.) All the figures are drawn to the same scale. The sections are taken at right angles to the urethra, and magnified two diameters. If C is compared with A it will be seen that vasectomy has produced no change at all, either in respect to size or the presence and distribution of gland tissue. On the other hand, if B is compared with A it will be seen that extreme atrophy has followed the ligation of the vessels of the spermatic cords. The gland tissue is only faintly made out in this specimen. For microscopic appearances of A, B, C, see Figs. 22, 23, 24.

### EFFECTS OF LIGATION OF THE VESSELS OF THE SPERMATIC CORD

There can be no doubt that ligation of all the vessels of the cord is followed by atrophy of the testis. In the case of partial ligature, Griffiths has shown that the results vary with age, and the vessels ligated. Actual section of the vessels is not the only way in which the blood supply to the testis may be cut off. A thrombosis may effect the same result, and thrombosis may occur spontaneously, or as an effect of operation on the spermatic cord.

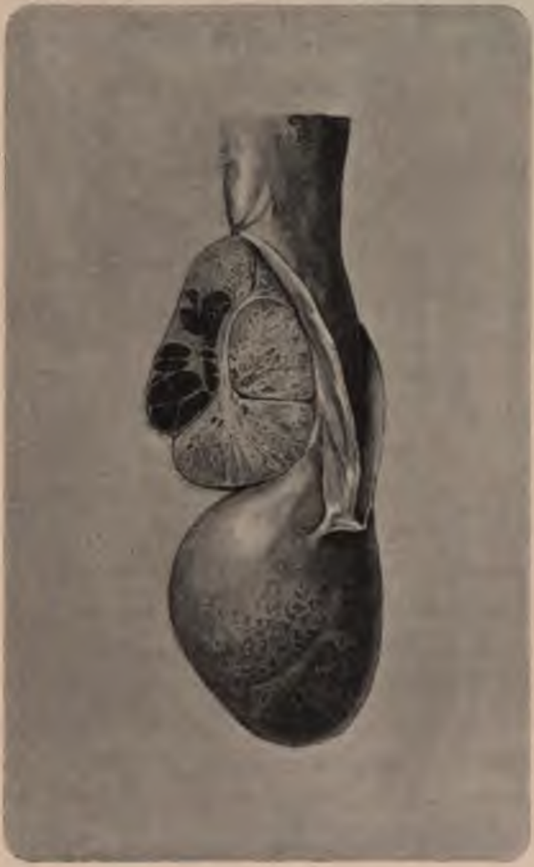

FIG. 26. Specimen No. 36A, Royal College of Surgeons. The testicle of a Southdown sheep on which, when a lamb, double vasectomy was carried out, the vas deferens being divided between two ligatures. In consequence of some interference with the blood supply complicating or following the operation, the testicle has undergone a remarkable degree of atrophy. The operation was carried out on March 3, 1902; on June 27 the right testicle was found to be quite small, consisting of a lower mass about the size of a filbert (lower end of epididymis), and an upper of the same dimensions. The vertical diameter of the entire organ, including the epididymis, is only 70 mm., and that of the body of the testicle alone 28 mm. The extreme vertical measurement of the left organ, which attained the full size, was 100 mm., that of the body of the testicle being 80 mm. The animal was killed slightly over a year after the operation. (Natural size.)

The result of such an accident after ligature of the vas is shown in Fig. 26,[1] which depicts the atrophy produced in the sheep's testis.

### THE NATURE AND FUNCTION OF CERTAIN ORGANS OF THE GENITO-URINARY SYSTEM

The fact that testicles are present in all vertebrate male animals, and that ablation of the testis is followed by an atrophy of the prostate, the vasa deferentia, the vesiculae seminales, Cowper's glands, and of the musculature of the urethra, shows that the testis is the master male genital organ, and that the other glands subserve only a secondary function.

*The prostate.* Although the prostate is found in most mammals, it is not universally present. It cannot therefore be regarded as an organ essential to generation. There are two main ideas regarding the function of the gland.

1. That it is a sphincter of the bladder.
2. That it is a secondary sexual gland.

The idea that it is a sphincter of the bladder has now been largely given up, owing to the fact that it is absent in the female, and that in many animals it is of such a form that it could not subserve this function.

That it is a sexual gland is proved by the following facts:—

1. That it is confined to the male sex.
2. That it enlarges rapidly at puberty with the other sexual organs.
3. That it exhibits seasonal activity in such animals as the mole and the hedgehog, which only pair at certain times of the year.

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[1] I am indebted to Messrs. Shattock and Seligmann for the use of this specimen.

4. That it fails to grow in eunuchs, that is in individuals who are castrated in youth.

5. That it atrophies after castration in adults.

No definite statement can be made as to its actual function, but it is probable that it secretes a fluid in which the spermatozoa can live and thrive.

E. Steinach (*Pflüger's Archiv*, 1894) stated that white mice were sterile after prostatectomy, although the testicular fluid contained spermatozoa.

Ivanoff (*Journal de Physiologie et de Pathologie Générales*, 1900), on the other hand, impregnated bitches by injecting into the vagina spermatozoa obtained from the epididymis and mixed with a ·5 per cent. solution of sodium carbonate. He suggested that the solution being alkaline performed the part of the prostatic fluid.

According to Stern (*The American Journal of American Science*, 1903), the prostatic fluid contains:—

Water . . . . . . . . . 98 per cent.
Sodium chloride.
Calcium sulphate.
Magnesium sulphate.
Phosphoric acid, combined with sodium, calcium, and magnesium.
Nucleo-proteid.
Fibrinogen.
Mucin.
An enzyme that clots testicular fluid.
Lecithin.
Cholin.
An amyloid substance (concretions).

*Cowper's glands.* The development of these glands varies very much in different animals, and usually in inverse proportion to the other secondary sexual glands. About the function of these glands, which open into the junction of the ecto- and endo-dermal portions of the urethra, less is known than about the prostate. That they are particularly related to the penile portion of the genital tract, is to be inferred from the fact that they are present (Richardson, *Development and Anatomy of the Prostate Gland*, 1904) in monotremata, in which animals the penis is a purely sexual organ, but absent in oviparous animals, such as the tortoise, in which the penis is only represented by a groove. That they are sexual glands is proved by the fact that they undergo a seasonal development in the mole and the hedgehog (Griffiths, *Journal of Anatomy and Physiology*, 1889–90), and that they atrophy after castration.

*Vesiculae seminales.* These sacs or organs are developed as buds from the Wolffian ducts, into which they usually open. The vesiculae seminales are less constantly present in the lower mammals than either the prostate or Cowper's glands. They are large in guinea pigs, small in the squirrel, and absent in the dog. Their absence points to the fact that they also are not essential to procreation. It is usually held that the vesiculae perform the functions of reservoirs for the seminal fluid, but there are some facts which point in the opposite direction.

In the boar, beaver, and elephant, the vesiculae open into the urethra independently of the vasa deferentia, and cannot therefore act as retention sacs. According to Quain they do not usually contain spermatozoa, which are, however, found in the expanded and sacculated portions of the vasa deferentia.

Ablation of one testicle is not followed by decrease of the vesicula of that side, as one might expect if the organ were a mere reservoir. Double castration performed on the young is, however, followed by an atrophy of both organs.

*Uterus masculinus.* This structure is met with in various degrees of development in different mammals. In the goat, for instance, it is of striking proportions, the upper part being bifid, and each horn continued down to the top of the corresponding testis. In man it is small, and lies hidden entirely within the prostate. On this account it was once thought that the prostate was homologous to the female uterus. That this view is untenable, is proved by comparative histology and anatomy. Histologically the prostate is a highly glandular, while the uterus is essentially a muscular, organ. Shattock has indicated, by his discovery of a hymen, that the prostatic utricle corresponds to both the uterus and vagina of the female.

Comparative anatomy shows that the prostate may exist in some animals as an organ quite distinct from the uterus masculinus, and in certain cases of mal-development in the human subject a similar condition may be found. The following is the description of a specimen now in the museum of St. Thomas's Hospital (No. 2699), originally recorded by S. G. Shattock (*Path. Soc. Trans.*, vol. 41) :—'The specimen is from a foetus below term which is reckoned female in sex, since the generative glands consist of two well-developed ovaries. . . . The clitoris is grooved on the inferior aspect, and the groove when traced backwards leads to a small aperture in the perineum, admitting the passage of a common probe. This aperture is that of the urethra, which, at a distance of 1 cm. above it, is surrounded by a full-sized and structurally normal prostate. The prostatic portion of the urethra measures 1 cm. in length, and opens into the urinary bladder. Behind the bladder lies a well-formed uterus, 2·2 cm. long, furnished with Fallopian tubes and ovaries, the ovaries being symmetrical, each 2 cm. in length and of normal microscopical structure. Below the uterus there is a vagina. . . . The vagina passes through the lower portion of the prostate, and opens into the urethra by an aperture which barely admits the point of a probe. The prostate presents the typical glandular and muscular structure.'

The female urethra corresponds with that portion of the male urethra which lies between the internal meatus and the opening of the ejaculatory ducts. Numerous mucous glands, which are always found opening into the female urethra, are probably the homologues of the glandular elements of the male prostate.

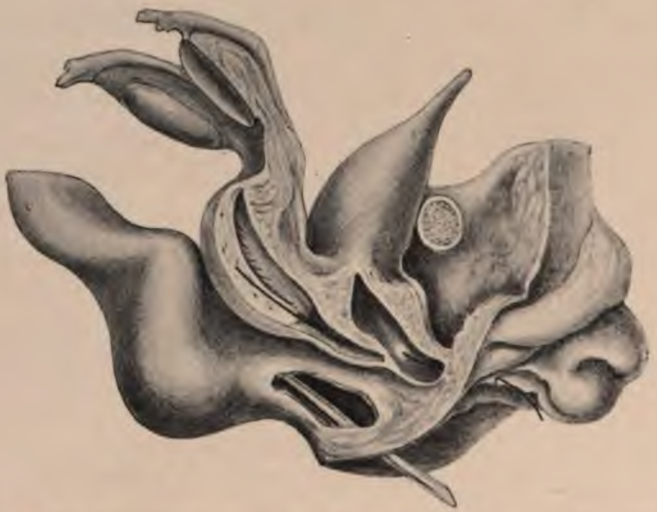

FIG. 27. The genital organs of a female foetus showing the presence of a prostate.

# CHAPTER III

## MORBID ANATOMY

UNDER this heading will be described the gross changes which occur in the gland in the process of its enlargement. The histology will be dealt with later. It need only be stated here that changes, sometimes slight, sometimes well marked, are obvious to the naked eye in a cross-section of the gland before any alteration is to be observed externally. No constant relation exists between the size of the organ, the alteration of its external configuration, and the histological changes. There is a general tendency in the process of enlargement for the gland to lose its normal pyramidal shape, and by a disproportionate increase in its antero-posterior diameter to become globular. Its external surface is generally smooth, and seldom presents excrescences such as may be seen on the vesical aspect of the gland. The increase in the transverse diameter causes the organ to encroach on the pelvic cavity, and to assume a closer relation to the pelvic floor and walls. In front it approaches the pubic ramus, laterally it bulges out the levator ani muscles, and posteriorly encroaches on the lumen of the rectum. The increase in the vertical diameter may be extra-vesical, intra-vesical, or both. An enlargement of the extra-vesical part of the gland will cause an increase in the distance of the bladder from the triangular ligament, and will therefore raise the vesical floor above the normal level. A great increase in this diameter may render the prostate palpable from the abdomen.

*Alteration in the bladder.* In the anatomical description it was noted that the prostate is an entirely extra-vesical organ, and that the bladder rests by a comparatively narrow surface on the base of the prostate. When the prostate enlarges it increases in both its vertical and transverse diameters. The effect of the increase in the transverse diameter is that a larger area than normal of the lowest part of the bladder becomes supported by the gland (compare Figs. 2 and 28). The vertical increase not only raises the neck of the bladder from the triangular ligament, but, in addition, causes an invagination of that portion of the bladder floor which lies round the internal meatus. The changes taking place in this region are best appreciated if they are studied by means of vertical sections taken through the internal meatus.

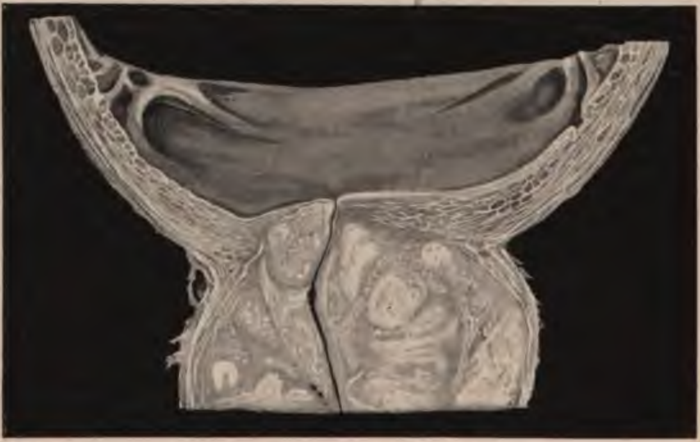

FIG. 28. A section through the junction of a bladder and prostate. The adenomatous change is well marked. The area of the bladder supported by the prostate is of greater extent than normal. There is a slight invagination of the vesical floor, and a thinning of the muscle about the internal meatus. (Natural size.)

If a bladder, into which a considerable projection has taken place, be opened, and the interior viewed from above, it will be seen that the urethra opens near the summit of the projection, and therefore at a certain distance above the apparent bladder floor; the distance above the internal sphincter, however, may be considerably more. The prostate, having filled the lower part of the bladder, with whose walls it is in apposition, has caused the mucous membrane to be reflected from the surface of the projecting prostate on to the bladder wall at some distance above the level

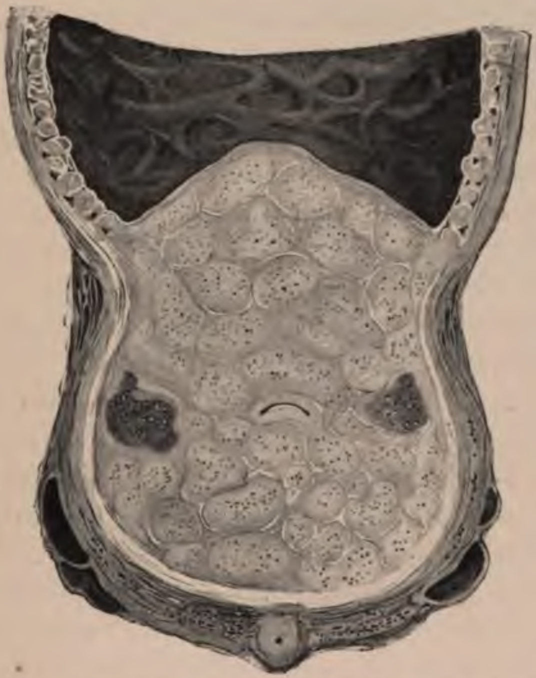

Fig. 29. A coronal section through a prostate and bladder. The prostate has grown into the bladder, and widely separated the sphincter. The floor of the bladder has been raised to an extent corresponding to the distance between a line drawn through the bottom of the vesico-prostatic groove and the cut edge of the mucous membrane. (Natural size.)

of the internal sphincter. This fact will be referred to again when speaking of the 'capsule' of the enlarged prostate in connexion with enucleation operations (see Fig. 75).

The protruding part is often at first horse-shoe shaped, but as it increases it assumes a ring form, and in this stage it may be likened to the projection of the uterus into the vagina. If the growth continues to increase evenly on all sides, the intra-vesical projection assumes the form of a cone, more or less acute. If the growth progresses unevenly, then a very irregular projection may be produced, and should the posterior part grow more rapidly than the anterior, the so-called 'third lobe' tumour (see page 77) is formed.

It may be said that a large prostate may exist with very little intra-vesical projection, but a large intra-vesical projection is nearly always part of a large general increase.

*Alterations in the internal meatus.* In the normal state the internal meatus is situated at the lowest part of the bladder. It forms a dimple, and is surrounded by a ring of muscle. From what has been said above, it is to be expected that very definite changes will be found at the internal meatus. These changes affect the position, the shape, and the surroundings of the meatus. The commonest change in the position is a forward one towards the pubes. Usually the meatus remains in the mid-line, but may be carried to one side or the other. If there is an intra-vesical projection of the prostate, the internal meatus will naturally be raised above the floor, and if this projection is well marked the actual opening of the urethra may come to lie a considerable distance—two, three, or more centimetres—above the bladder floor.

The usual shape of the meatus is a dimple, and it may continue to have this form although the prostate is greatly enlarged, provided the gland does not insinuate itself to any degree into the bladder. If this should happen, the shape of the meatus will depend upon whether the growth of the prostate takes place uniformly or not. If a uniform and well-marked intra-vesical projection has occurred, the internal meatus becomes patulous and funnel-shaped, so that it will in many instances easily admit the index finger. If, on the other hand, the

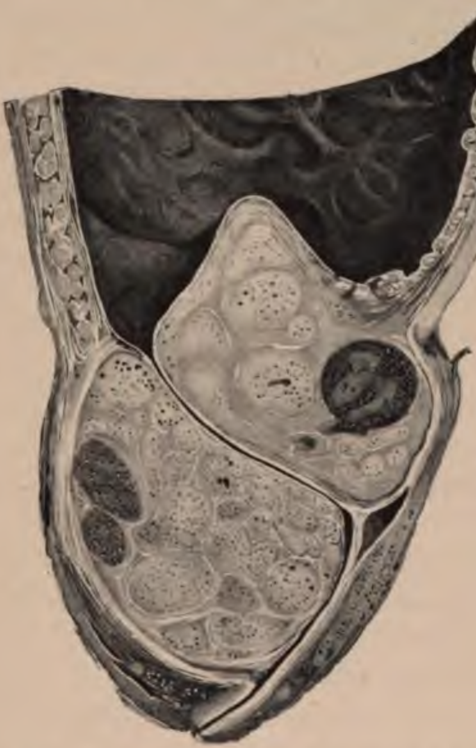

FIG. 30. A sagittal section of the prostate and bladder. The internal meatus has been carried forward. The urethra is distorted, so that the portion proximal to the openings of the ejaculatory ducts lies at a right angle with that portion beyond the openings of these canals. The prostatic tissue below the ejaculatory ducts has escaped the adenomatous transformation. The two adenomatous masses above and below the urethra are quite continuous with one another. (Natural size.)

enlargement takes place more rapidly on one side than on the other, the opening assumes a linear or crescentic outline, the axis being either transverse or antero-posterior, according to the position of the growth.

If the prostate enlarges for the most part extra-vesically, the internal sphincter will still surround the internal meatus, but there is usually, even then, some thinning of the muscle ring. It will be seen (Fig. 28) that the usual triangular shape of the internal sphincter, as seen in section, has undergone an alteration. The enlarged prostate, as it bulged the floor, has also caused a thinning of the muscle by spreading it out over itself. This attenuation is most advanced immediately round the urethra, where the muscle fibre fines off into a very acute angle, but still forms a contractile ring at the internal meatus. In some cases this attenuation takes place, as it were, within the thickness of the bladder wall, the bladder viewed from the inside remaining almost normal in appearance. As the prostate continues to grow, the attenuation of the sphincter becomes more and more marked, until the prostatic gland tissue comes to lie immediately under the mucous membrane. By this time the growth has pushed its way into the bladder and widely stretched the sphincter. Such a condition of things is well shown in Fig. 30.

The dilatation of the sphincter is purely mechanical, as far as my experience goes. I have never seen anything to suggest an invasion of the muscle, as by a new growth.

In those cases in which the intra-vesical projection reaches its maximum, the internal meatus will open on the apex of the cone, and there will be added, so to speak, an intra-vesical section of the urethra surrounded entirely by gland tissue. The internal sphincter in such a case is to be looked for at or below the base of the intra-vesical cone, and separated from the urethral canal by a considerable extent of prostatic tissue. The result of this arrangement is, that the internal sphincter, were it able to act in spite of its distension, would close, not the internal meatus, but a portion of the urethra at some point distal to its actual opening into the bladder.

*Alterations in the urethra.* These alterations may be considered in regard to—

1. Length.
2. Axis.
3. Dimensions.
4. Shape.
5. Structure of the wall.

1. Whatever form the vertical increase in the gland takes, whether it be extra or intra-vesical, the length of the urethra measured along a catheter will be increased. The internal meatus will lie at a greater distance from the external meatus than normally, and a catheter will therefore have to be introduced to a greater depth before its point will enter the bladder.

2. Normally, the distal portion of the prostatic urethra forms a slight angle with a proximal portion. The alteration in the axis will depend upon the position of the growth in the prostate. The commonest alteration is an increase in the normal antero-posterior angle, usually due to the development of the growth above and behind the entrance of the ejaculatory ducts, whereby the proximal portion of the urethra is pushed forwards. In extreme cases the two portions of the prostatic urethra may form a right angle with one another (see Fig. 30). If the growth takes place with a greater rapidity on one side of the urethra than on the other, this canal will be correspondingly deflected either to the right or to the left, but such a distortion in our experience is not so common as might be expected.

3. The proximal portion of the urethra, as has been explained, is often patulous, even though the intra-vesical projection is

small. About the middle of the gland, the urethra, as seen in cross-section, usually forms a linear slit, and though this slit may measure as much as two or three centimetres, and though it may admit of easy dilatation, yet the capacity of the canal to contain fluid is not great. This is due to the fact that the sides of the canal are kept in apposition by the surrounding growth. The distal portion of the urethra, that is, that portion which lies beyond the ejaculatory ducts, is usually the least altered of all.

4. The shape of the proximal portion of the urethra is, as a rule, but little altered, remaining circular in outline, though patulous. The middle portion of the urethra is, as a rule, converted into a linear slit directed antero-posteriorly (see Fig. 50). The earliest change from the normal or crescentic outline is that of a triradiate form (see Fig. 32), the antero-posterior radius being the longer. This radius is as a rule increased while the two lateral radii soon disappear. This slit-like form of the urethra is seen in prostates which are but little increased in bulk (see Fig. 41), and is due to the growths taking place evenly on both sides of the canal. Such growths in the lateral masses compress the urethra from side to side, while they stretch it in an antero-posterior direction. The distal portion of the urethra is much less liable to distortion, retaining its circular outline and longitudinal folds.

5. The normal prostatic urethra is as a rule surrounded by an area sparsely supplied by gland tissue. One of the earliest changes noted in the enlargement of the organ is, the approach of the glandular elements towards the mucous membrane of the urethra, and before any appreciable enlargement has taken place the glandular material comes to lie immediately under the mucous membrane and thus replaces the normal muscular lining. The mucous membrane itself, in cases of large growths, is so thin that in almost all cases which have been examined any attempt to raise

it leads at once to its rupture. The least affected portion of the urethra is the distal part, and it is here also that the prostatic gland tissue is least affected by pathological change. Sections of this portion of the urethra taken, from cases which present quite a marked degree of enlargement, often show a well-marked muscular urethral wall.

### THE EFFECTS PRODUCED BY THE ENLARGED PROSTATE ON THE REST OF THE GENITO-URINARY TRACT

The effects of the enlarged prostate upon the urinary tract are produced by the obstruction to the outflow of urine. They differ but little from those produced by other causes of obstruction to the urinary outflow.

*The bladder.* The earliest effect is to produce an hypertrophy of the muscular coats, which leads to fasciculation and a possible pouching of the mucous membrane. When the obstruction becomes more complete, and the bladder has been often distended, a certain amount of stretching of the organ takes place, so that the quantity of urine held without discomfort may be very considerable, but even when the capacity of the bladder is very great, the walls are nearly always thicker instead of thinner than normal. Considering that the change in the prostate producing the obstruction to the outflow of urine is a slow process, primary dilatation of the bladder would not be expected, and, as a matter of fact, rarely if ever occurs. The pouching of the mucous membrane through the unprotected spaces left by the hypertrophied muscle bundles takes place very gradually. These pouches, although they may be formed at any part of the bladder, are usually found, if of any size, on the posterior surface of the organ just above the trigone, or in the immediate vicinity of the openings of the ureters. When in the latter situation they may give rise to the impression that the openings of the ureters are themselves dilated. The largest pouches, which may contain many ounces of urine, communicate with the bladder proper by a comparatively small mouth situated just above a line drawn between the two ureters.

*The post-prostatic pouch.* As a result of prostatic obstruction, it is usual to describe the formation of a post-prostatic pouch. Although it has been considered that this pouching is primary, and the enlargement of the prostate secondary, the more commonly accepted view is the reverse of this. It is held that the obstruction to urination, and possibly an inflammation, causes a weakening of the muscle fibres, and a consequent yielding of the weakest portion of the bladder. It is certainly true that a post-prostatic pouch does exist, if by this is meant a pouch or portion of the bladder lying below the plane in which the internal meatus opens. Examinations after death and during operations on many cases of enlarged prostate do not confirm the explanation that this pouch is entirely due to the giving way of the bladder wall. This view would be difficult to accept on anatomical grounds. If the level of the lowest part of the bladder were depressed, it could only be so by a sinking of the bladder between the prostate and the rectum, which certainly does not occur, although a pouching backwards of the bladder wall above the trigone can take place at the expense of the lumen of the rectum. At the same time it should be remembered that the majority of bladders which exhibit this phenomenon are thicker and stronger than usual, as a result of their hypertrophy.

There is, however, another explanation than that usually given. It has been shown that, as the prostate enlarges, a greater area of the bladder becomes supported by the growing organ (see Fig. 28), and in such cases the bladder walls arise from the base of the prostate as from the circumference of a disc, instead of from a point immediately about the internal meatus.

This process is often accompanied by a pushing forward of the internal meatus (see Fig. 30). The result of these changes is that the bladder wall passes back from the internal meatus in a more or less horizontal direction instead of in a vertical, and there is thus formed, so to speak, a more or less level horizontal area at the base of the bladder which cannot be obliterated by any contraction of the organ. The intra-vesical projection of the prostate may, as has been explained, raise the internal meatus considerably above the level of the lowest portion of the bladder floor. It is to these three factors, viz. the broadening of the bladder floor, the carrying forward of the internal meatus, and the existence of an intra-vesical projection, that the formation of the so-called post-prostatic pouch is due. The lowest point of the post-urethral portion of the bladder floor is certainly not on a lower level than normal; in fact, it is often actually on a higher level—due to the fact that the growing prostate has raised the mucous membrane covering the bladder floor (see Fig. 29 and page 59).

*Ureter and kidney.* Here again the results are similar to those due to any other obstruction to the outflow of urine. The ureters become more or less dilated. Whether this dilatation is caused by the increased thickness of the bladder wall, or is due to the pressure of a distended bladder on the oblique intramural portions of the canals, or to simple difficulty of micturition, is unsettled. Whatever the cause, the pelvis of the kidney soon follows suit, and a slight, moderate, or well-marked dilatation results. The kidneys themselves are unable, without deterioration, to withstand the increased pressure, and show signs of interstitial nephritis. Moreover, at the time of life at which enlargement of the prostate occurs, it will happen that the kidneys are often, quite apart from prostatic trouble, the seat of some chronic change, and it is important to bear this in mind when the question of operation is being discussed.

# · CHAPTER IV

## MORBID HISTOLOGY

*The encapsuled form of prostatic enlargement.* The external configuration of the prostate shows no alteration from the normal for some time after pathological changes have taken place in its interior, hence the macroscopic appearances are best studied by means of transverse sections. The first change to be seen is the appearance of white opaque specks in the normal spongy tissue of the prostate. These specks are at first seen wherever gland tissue exists—that is, at the sides and behind the urethra, but also in front of the canal if gland tissue should happen to be present there.

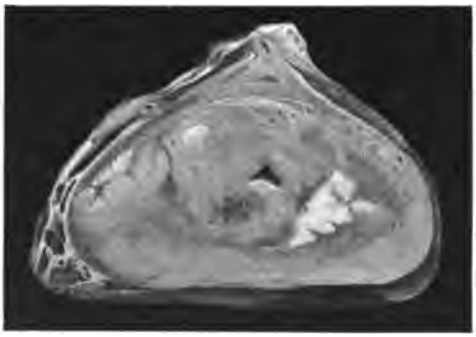

**FIG. 81. Shows the early appearance of the white areas. They are very ill defined. (Natural size.)**

As time goes on, the white specks increase in size and others make their appearance, until certain areas become differentiated from the rest of the gland substance. About this time the normal arrangement of the stroma strands becomes altered. Instead of radiating out from a point behind the urethra, they become displaced by the white areas, between which, and around which, they now run. Some of the white areas continue to increase in size and outgrow their fellows. Their outline becomes more and more definite, and as they increase they seem to come together and to approach the urethra rather than the periphery of the gland. Prostatic tissue which has not been invaded by the white areas loses its spongy character and becomes denser in appearance, but its nature is still shown in some specimens by the occurrence of prostatic calculi, and in others by the existence in it of outlying white areas like those occupying the more central part of the gland.

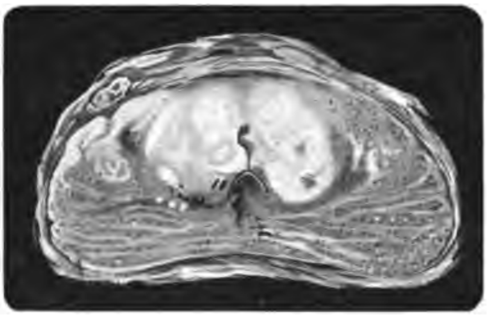

FIG. 32. The white areas have appeared immediately in front of the urethra. The posterior part of the gland is unaffected. (Natural size.)

In the next stage the white areas assume the appearance of distinct tumours. Such tumours are seldom simple, but consist of a series of smaller tumours bound together by a capsule. The peripheral part of the organ, except towards the posterior and inferior part of the gland, has lost all traces of normal prostatic tissue, and shows distinct signs of concentric lamination. Lying in this area in appropriate sections can often be seen the ejaculatory ducts (see Fig. 35).

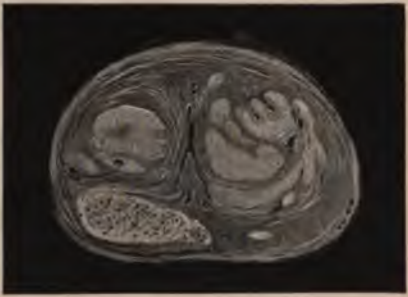

FIG. 33. The white areas are scattered more or less throughout the substance of the gland. The intervening tissue has lost its spongy appearance. There is an indication of the formation of a circumferential envelope. (Natural size.)

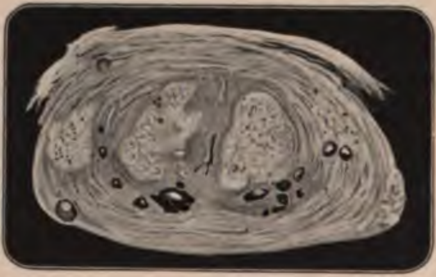

FIG. 34. The white areas have the appearance of definite tumours, which are situated near the urethra. The outer portion has lost its normal texture, and the fibres run concentrically. Calculi and a small white mass indicate the presence of glandular elements in this situation. (Natural size.)

The thickness of this outer layer is very various, and may measure as much as 1 cm. in places. A stage further the transverse section presents a central area about the urethra, and surrounding this central portion a fibrous laminated envelope. The central portion is made up of a series of small enucleable, whitish yellow tumours, and between them fibrous tissue running in every direction and encircling them (see Figs. 51 and 70). The outer laminated sheath is much decreased in thickness. It has gained in definition what it has lost in bulk.

Microscopic sections made from these yellowish white tumours show that they are largely composed of glandular tissue lying in a fibro-muscular stroma. In some instances the whole structure differs but little from that of the normal gland. The alveoli are normal in shape, and show intra-alveolar plications of the walls. The lumen is of the usual size, or a little dilated. The stroma is shown by appropriate stains to be composed of fibrous and muscular tissue in fairly just proportions.

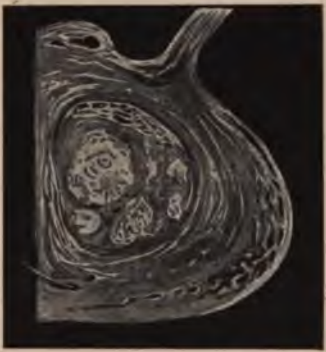

FIG. 35. Transverse section of half a prostate. The urethra lay to the extreme left edge of the picture. A definite tumour is seen surrounded by a fibrous envelope. A bristle has been placed in one of the ejaculatory ducts. No. 4312, Royal College of Surgeons. (Natural size.)

Occasionally an alveolar space is filled with epithelial cells. This appearance is not apparently due to an overgrowth of cells, but to the fact that the section has passed near the end of a glandular diverticulum, and the epithelium has been cut through in a plane parallel to its surface, or to the fact that the section has passed very close to the surface of the epithelium, which is thus viewed from above.

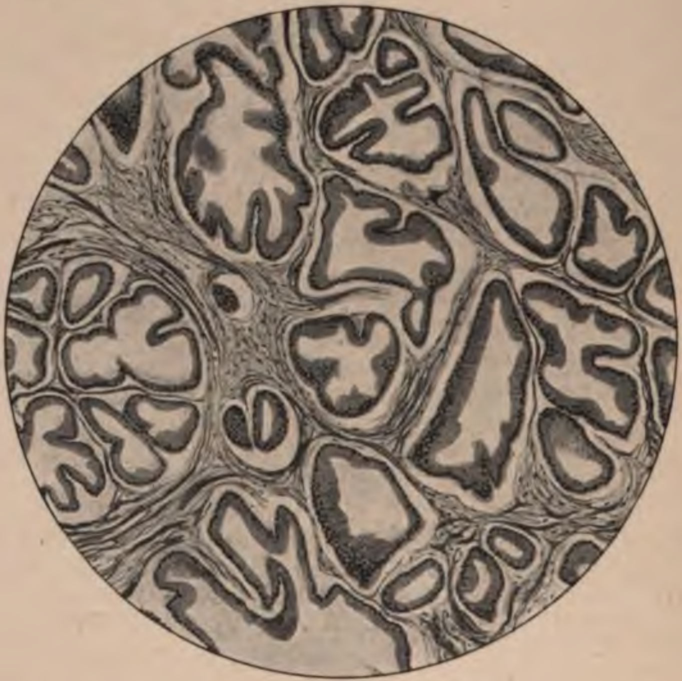

FIG. 36. A microscopic section of a small encapsuled tumour removed from a larger tumour enucleated from the prostate.

In other specimens the appearances are different or differ in some parts of the sections. The glandular alveoli have evidently undergone dilatation. The intra-alveolar processes are either small or absent. The whole structure is more open. The alveoli are large, and stroma reduced in corresponding amount. The epithelium is represented by a single flattened layer of cells. The contents of the alveoli vary. Sometimes they are empty, sometimes filled with a structureless material which stains somewhat slightly. In other cases there are seen shed epithelial cells and finely granular polynuclear cells, also large and small mononuclear cells and fat droplets. Amyloid bodies are constantly seen, and more rarely calculi. The structureless material above mentioned can be sometimes seen to be breaking up into what appears to be amyloid bodies.

It has been stated the proportion of muscle and fibrous tissue in the stroma is often normal. It is rare indeed to find sections in which muscular tissue is absent, if the proper stains be used, and in some cases the muscle tissue is even increased at the expense of the fibrous.

The tumours are usually composed of a number of smaller ones, themselves enucleable from the main mass. In two specimens, single tumours have proved to be almost entirely made up of fibro-muscular tissue, while their fellow tumours presented the ordinary glandular structure. Careful examination revealed in both instances the remains of glandular alveoli, but to such an extent had the glandular elements degenerated that their recognition was a matter of some difficulty.

These are the only two instances in which a tumour which could be described as a fibro-myoma has been met with. Their presence is of interest, because the tissue of which they are composed, is found in some of the non-encapsuled varieties of enlargement.

Microscopic sections taken from the edge of the small component tumours show a process of encapsulation going on. This process is seen in the case of the compound tumour itself, as well as in the case of its smaller contained tumours. Fig. 37 represents two small tumours, or two lobes of one tumour. The glandular alveoli in some cases show intra-alveolar processes, and in other cases dilatation of the lumen with flattening of the epithelium. Around the advancing edge of the adenoma, the surrounding tissue is becoming laminated and being driven to take a concentric direction. This compressed area is mostly devoid of gland tissue, but flattened gland spaces can be seen. Further removed from the tumours the glandular alveoli again appear, but are somewhat distorted in shape. What is seen here on a small scale is repeated on a much larger in the outer laminated area of the gland. It was stated that the outer part of the gland lost its glandular and spongy appearance and became dense. Microscopical examination of this outer part or envelope still shows, however, compressed gland spaces lying between the concentric laminae (see Figs. 53 and 57).

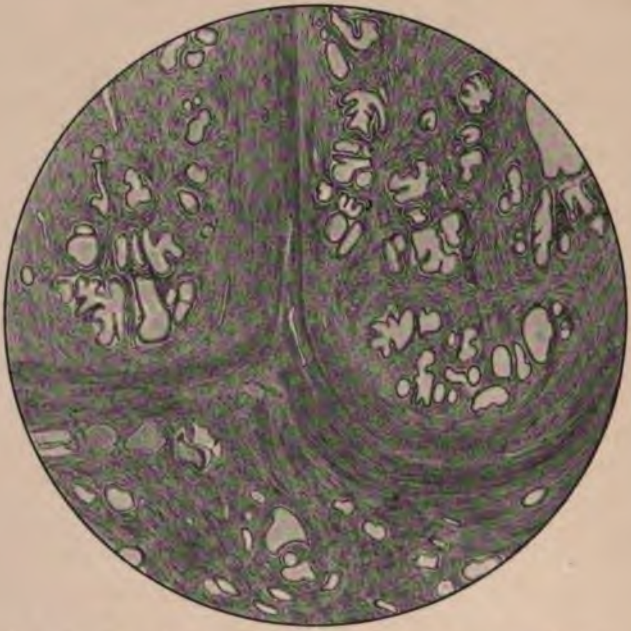

FIG. 37. The edge of an adenoma, showing the encapsulation.

Perhaps the greatest interest lies in the absence or presence of the signs of inflammation in the enlarged prostate. Collections of small round lymphoid cells are almost constantly present in the stroma of all enlarged prostates. These cells, however, are not of an inflammatory origin, and are, moreover, found in the prostates of young children. Finely granular polynuclear cells are seldom met with outside the alveoli, except in the region near the urethra and bladder. Plasma cells, so commonly found in chronic inflammatory processes, are extremely rare (see p. 91). Lymphoid cells, similar to those above referred to, are met with in adenomata of the breast and in thyroid adenomata. It may therefore be said that the signs of inflammation are wanting in the stroma of enlarged prostates, but that the epithelium may show signs of a catarrhal proliferation.

*Position of tumours.* From what has been described above, it would appear that the pathological change, whatever its exact nature, is one which concerns the glandular tissue. In the normal prostate, gland tissue surrounds the urethra on all sides except for a narrow strip in front. Even here it may exist and replace the anterior commissure. It is also found both above and below the ejaculatory ducts. Tumours can therefore develop in any of these situations. The shape or form of the tumours will depend on the site of the pathological change. If this takes place in one of the lateral masses of the gland, a single tumour is produced (see Fig. 62). If in both lateral masses, then two tumours, situated one on either side of the urethra (see Fig. 64). If again, the gland matter behind and on both sides of the urethra is affected, then a horse-shoe tumour is formed (see Fig. 68).

The toe of the horse-shoe tumour is directed backwards, and as far as observation goes, always lies above the ejaculatory ducts, and therefore occupies a higher position than the heels, which point somewhat downwards and forwards. In this connexion it may be noted that the gland tissue near the bladder is more usually the seat of pathological change than that more distant. The part of the prostate below the ejaculatory ducts often escapes gross alteration and is simply compressed by the growth in other parts. This is shown in Fig. 30, where it is seen that the glandular tissue behind the urethra and below the ejaculatory ducts is but little altered. Should glandular tissue be present in front of the urethra, then it is possible for a ring tumour to be constituted (see Fig. 50).

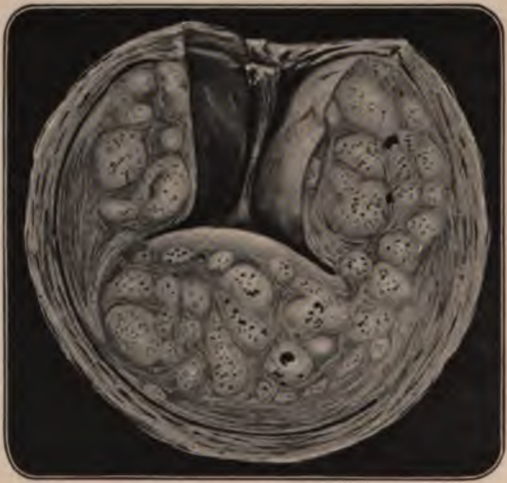

FIG. 38. A transverse section of an enlarged prostate seen from above. The urethra has been laid open in front. The tumour behind the urethra is seen to be continuous with that in the right lateral mass. Externally lies the 'capsule'. The line of cleavage between it and the tumour formation is indicated by a dark line. (Natural size.)

The form of projection of the prostate into the bladder will depend, to a certain degree, on the situations of the tumours in the gland. If the pathological change took place in the form of a ring, the projection will be a uniform one; if behind and at the sides of the urethra, then in the form of a horse-shoe; if on either side of the urethra, then as two lateral projections, one on either side of the meatus. This latter form may, at the anterior and posterior parts, raise a ridge of stretched prostatic tissue so as to complete the ring around the internal meatus.

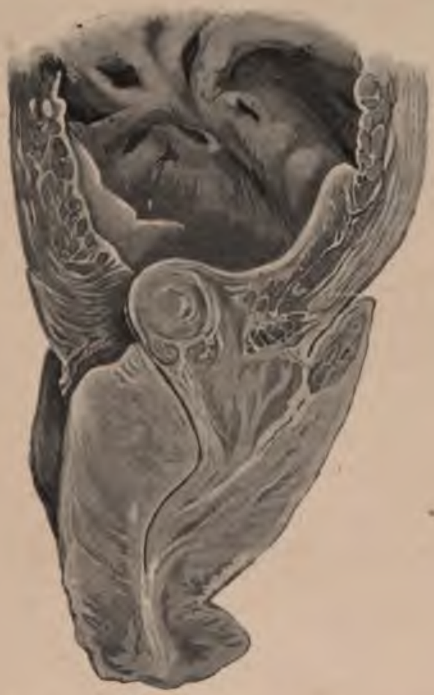

FIG. 39. A median sagittal section of a bladder and prostate. Immediately behind the internal meatus and under the mucous membrane is a small isolated adenoma. It is marked off from the rest of the organ, and is the only part affected by pathological change. (Natural size.)

The third lobe tumour so often described by authors is almost invariably an extension from a tumour which has developed in one of the lateral lobes, or springs from the toe of a horse-shoe shaped tumour (see Figs. 38 and 30).

Occasionally, an isolated nodule is found to lie in the position of the so-called third lobe, and to be situated immediately under the mucous membrane and apparently within the internal sphincter, and separated from the prostate proper. It is possible that such a tumour arises from the isolated prostatic tubules, which are found in the normal prostate to occupy the position assumed by such a growth (see p. 20).

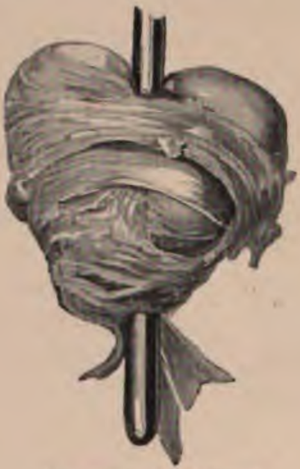

Fig. 40. (Natural size).

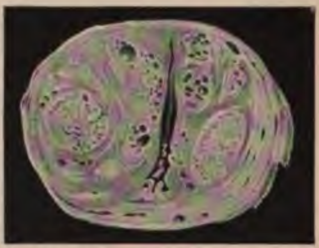

Fig. 41. A cross-section of Fig. 40. (Natural size.)

*The relation between the size of the organ and the extent of the pathological change.*

There does not appear to be any definite relation between the size of the organ and the progress of the pathological change. This is well shown if Figs. 41 and 50 are compared. Fig. 41 represents a transverse section of a specimen removed by prostatectomy. It had an antero-posterior measurement of 3·5 cm. and weighed 20 grams (5 drachms). Fig. 50 represents the transverse section of a specimen obtained in the same way. It has an antero-posterior measurement of 5·5 cm., and weighed 152 grams. If the two drawings are examined it will be seen that they differ only in size, in fact the smaller is a miniature of the larger.

### THE NON-ENCAPSULED FORM OF ENLARGED PROSTATE

What has just been written applies for the most part to the adenomatous or encapsuled form of enlargement. There remains the non-encapsuled 'fibrous' or 'diffuse' variety to be dealt with. What the nature of this change really is, has never been satisfactorily determined. It is met with in a comparatively small number of cases (15 per cent.). The clinical details differ not at all from those observed in the encapsuled form. An attempt to deal by enucleation with this variety of enlargement fails, and portions have to be removed piecemeal. Microscopic examinations of such fragments seem to point to a rough division into two classes.

In the first, the appearance may differ but little from those seen in sections taken from the encapsuled form, or from the normal gland. In places the alveoli are well formed, and the epithelium of normal type. In other places the alveoli are irregular in shape or dilated, and the epithelium is flattened or wanting. The proportion of fibrous and muscular tissue in the stroma is not far removed from the normal. It is very unusual to find that muscular tissue is wanting. Elastic tissue is also present.

In the second variety, which is much rarer, the changes are more profound, and little resemblance to the normal gland is seen. The gland tissue is altogether atrophic. The alveoli are not compressed or flattened so much as shrunken. The epithelium, which may fill the alveoli or surround a lumen, takes the stain very badly, and is evidently degenerated in a marked degree. The stroma, which occupies nearly the whole field, shows bundles of fibres, often massive, which interlace in a most intricate manner. Proper staining shows these bundles to consist of muscle fibre, which is thus demonstrated to form a large proportion of the growth. Signs of inflammation are as wanting in this as in the other form, and it has not been possible to

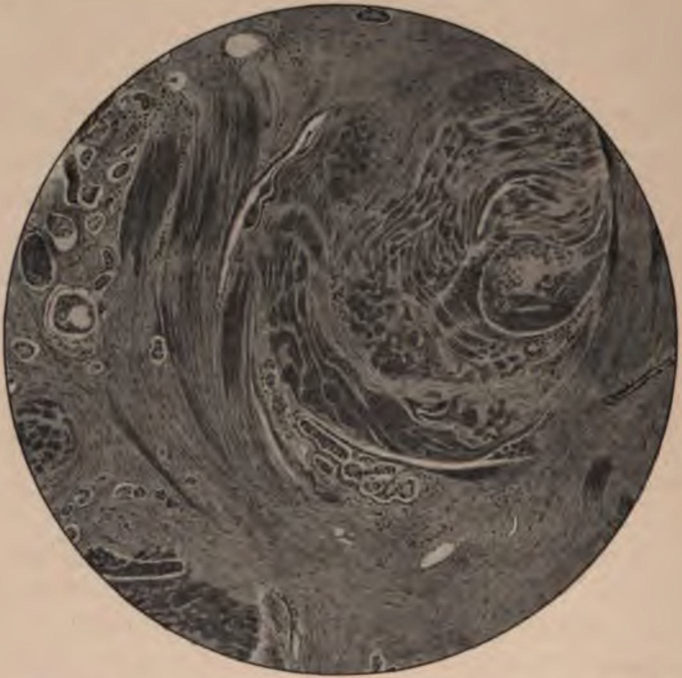

FIG. 42. A microscopic section taken from a portion of tissue removed by a morcellement prostatectomy. The enlargement was exceedingly tough and showed no signs of encapsulation. The darker wavy bundles are composed of plain muscle fibre. The lighter staining material is fibrous tissue. The remains of shrunken glandular alveoli are to be seen.

demonstrate anything at all approaching scar tissue. It is possible that these two varieties of the non-encapsuled form are only the extremes of a similar process, since the intermediate forms seem to exist and to show varying amount of gland tissue and stroma.

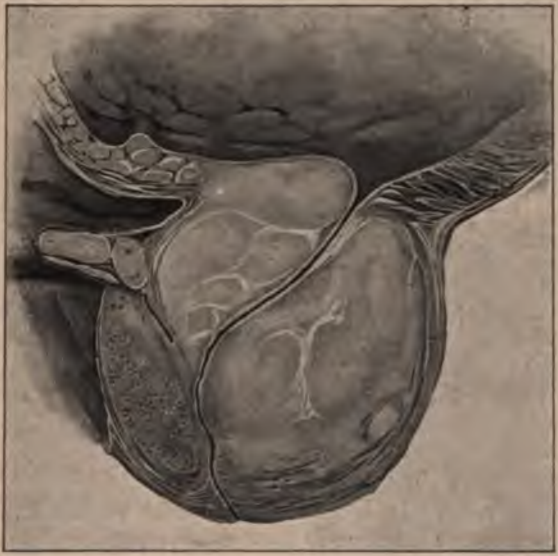

FIG. 43. A sagittal section of a bladder and prostate obtained in the post-mortem room. The whole gland, with the exception of the part below the ejaculatory ducts, has undergone a pathological change. The affected portion of the gland is denser than normal, but does not show the yellow-white tumours to the same extent as the encapsuled form of enlargement. There is very little indication of a main external envelope. An attempt was made to shell out the tumour, but failed on account of the want of encapsulation. The alterations in the surrounding parts are the same as are met with in the encapsuled form. (Natural size.)

There is considerable difficulty in stating what are the naked eye appearances of the prostates from which these two varieties have been removed, and no opportunity has occurred of examining such a case after prostatectomy. If recourse is had to post-mortem specimens some light is gained. It is not unusual to meet with cases of prostatic enlargement of moderate dimension and slight intra-vesical projection, in which the cut surfaces show white or yellow areas such as have been described as occurring in the early stages of the adenomatous variety. The gland seems more evenly affected, and there is little or no sign of encapsulation. There may be a small enucleable mass in some cases, but there is no sign of the formation of any circumferential 'main capsule'. The cut surfaces of some of the fragments removed from prostates by morcellement show similar yellow and white areas, and occasionally small enucleable tumours. It is possible, therefore, that the non-encapsuled forms are of the same nature as the encapsuled, but the encapsulation has become more complete in the latter, because there has been a more rapid growth of certain of the tumours, while in the non-encapsuled variety the change has affected the whole gland to the same degree.

An examination of a large series of prostates would seem to support this view. It is possible to place at one end of the series a distinctly encapsuled tumour, and at the other a distinctly non-encapsuled enlargement, and yet to fill the space between these two extremes with gradually changing forms. The non-encapsuled forms may be, perhaps, likened anatomically to the diffuse adenomyoma of the uterus, in which the myometrium may be, for wide extents, the seat of a glandular growth arising in connexion with Wolffian tissue.

# CHAPTER V

## BACTERIOLOGY

### THE URINE

For the purposes of this investigation the urine was drawn off into sterile test-tubes with the utmost care, and on fourteen occasions a bacteriological and a cytological examination was made of the deposit. In every instance the prostate from these cases was also subjected to a complete bacteriological investigation. It will be seen that pus was only present in six out of fourteen specimens which were examined, and in these six the bacillus coli was obtained in five instances and the staphylococcus albus twice, while the bacillus coli was found twice apart from the presence of true pus in the urine. The staphylococcus albus was isolated from the urine on five occasions, and was twice associated with the presence of pus. It is of interest to find that two organisms of such totally different pathogenicity as the bacillus coli and the staphylococcus albus should be present in almost an equal number of cases, and that the organism of low virulence should be accompanied by the presence of pus in the urine in two cases as against five in which the colon bacillus was found.[1] Although this bacillus

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[1] In all cases as much as 5-10 c.c. of urine were added to culture tubes of McConkey's bile salt medium, and incubated anaerobically at 42° C., while two or three loops of the urinary deposit were used for the aerobic cultures.

(B. coli) attains such a high degree of virulence under certain conditions, and may rapidly lead to the death of the patient—as, for example, in peritonitis—yet in the urine it may usually be regarded as an organism of low pathogenicity. In some instances it is not even associated with the presence of pus; two examples of such a condition have been already quoted in the present series. Considering the frequency with which this organism occurs in human urine, one would have surmised that it would have been found more frequently than these results have proved to be the case. It would not be unnatural to suppose that the presence of this organism in the urine in cases of enlarged prostate gland would hinder the progress of a case of prostatectomy, and might even lead to a fatal issue, but it is probable that this unfortunate circumstance only occasionally occurs at the present day.

The cultural tests of the colon bacilli which were isolated in all these cases were fully investigated. In every instance the organism labelled as the colon bacillus gave the following reactions:—It was Gram negative, formed reddish colonies on Drigalski and Conradi's medium, produced indol in twenty-four hours, formed gas in glucose gelatine without liquefaction of the medium, acidified and clotted milk, acidified and produced gas in lactose, mannite, and McConkey's medium, the last-named under anaerobic conditions at 42° C. Numerous other tests were also applied, but positive results with those referred to were regarded as essential. The only noteworthy points to be especially mentioned are that the colon bacillus in the urine usually shows exceptionally well-marked beading (specimens stained with Leishman's stain are often quite remarkable), and that it usually takes much longer to clot milk than when obtained from many other pathological sources.

## TABLE I

To Show the Results of the Bacteriological Examination of the Prostate Gland and Urine in Fourteen Cases of Prostatic Enlargement.

| | | Prostate. | | Urine. | |
|---|---|---|---|---|---|
| *No. of Case.* | *Nature of Tumour.* | *a. Cytological Examination of Exudate.* | *b. Bacteriological Examination of Tumour.* | *Cytological Examination of Deposit.* | *Bacteriological Examination of Urine.* |
| 1. | Adenoma. | Few finely granular polynuclear cells seen. Large vacuolated cells numerous. | B. coli; a streptococcus. | — | Sterile. |
| 2. | Fibro-Adenoma. | Ditto. | B coli; a diplococcus. | Pus corpuscles very numerous and also Gram negative bacilli. | B. coli. |
| 3. | Cystic Adenoma. | Ditto. | Staphylococcus albus. | Red blood corpuscles and a few leucocytes. | Staphylococcus albus. |
| 4. | Cystic Adenoma. | Ditto. | Staphylococcus albus. | Pus corpuscles numerous. | Staphylococcus albus. |
| 5. | Adenoma. | No milky fluid seen. | Sterile. | Pus corpuscles numerous. | B. coli. |
| 6. | Adenoma. | Few finely granular polynuclear cells present. Large vacuolated cells numerous. | Staphylococcus albus. | Red blood corpuscles and a few leucocytes. | Staphylococcus albus. |
| 7. | Adenoma. | Ditto. | B. coli. | *Few* finely granular polynuclear cells present. | B. coli. |

## TABLE I (*continued*)

| | | PROSTATE. | | URINE. | |
|---|---|---|---|---|---|
| *No. of Case.* | *Nature of Tumour.* | *a. Cytological Examination of Exudate.* | *b. Bacteriological Examination of Tumour.* | *Cytological Examination of Deposit.* | *Bacteriological Examination of Urine.* |
| 8. | Adenoma. | Ditto. | Staphylococcus albus. | — | A diphtheroid bacillus. |
| 9. | Adenoma. | — | Sterile. | Finely granular polynuclear cells present. | B. coli. |
| 10. | Cystic Adenoma. | Few finely granular polynuclear cells present, also large vacuolated cells, Gram negative bacilli and Gram positive cocci. | B. coli. | Pus corpuscles numerous, also large beaded bacilli. | B. coli. |
| 11. | Adenoma. | — | Staphylococcus albus. | Pus corpuscles present. | Staphylococcus albus. |
| 12. | Fibro-Adenoma. | Few finely granular polynuclear cells seen; large vacuolated cells numerous, cocci also present. | Staphylococcus albus and citreus. | Few finely granular polynuclear cells present. | Staphylococcus albus. |
| 13 | Fibro-Adenoma. | Finely granular polynuclear cells very numerous. Large vacuolated cells also present in large numbers. | Staphylococcus albus and a streptococcus. | No cells present in centrifugalized urine. | Sterile. |
| 14. | Fibro-Adenoma. | Ditto. | Sterile. | Pus corpuscles numerous, also epithelial cells. | B. coli. |

## TABLE II

### To Show the Results of the Bacteriological Examination of the Prostate Gland in Fourteen Cases of Prostatic Enlargement.

(No bacteriological examination of the urine was made in these cases.)

| *No. of Case.* | *Nature of Tumour.* | PROSTATE. | |
|---|---|---|---|
| | | *a. Cytological Examination of Exudate.* | *b. Bacteriological Examination of Exudate.* |
| 1. | Cystic Adenoma. | Few finely granular polynuclear cells present, also endothelial and epithelial cells and Gram positive cocci. | Staphylococcus albus. |
| 2. | Adenoma. | Finely granular polynuclear cells abundant. Endothelial cells scarce. | Staphylococcus albus, aureus, citreus, and a diplococcus. |
| 3. | Cystic Adenoma. | Small mononuclear cells only. | A new pathogenic bacillus. (See text.) |
| 4. | Myo-fibroma. | No milky fluid present. | Sterile. |
| 5. | Adenoma. | Few finely granular polynuclear cells and large vacuolated cells present. | Sterile. |
| 6. | Adenoma. | — | Sterile. |
| 7. | Adenoma. | Few finely granular polynuclear cells present; mononuclear cells abundant. | B. coli ; a diplococcus. |
| 8. | Adenoma. | Ditto. | Staphylococcus albus. |
| 9. | Adenoma. | Ditto. | a streptococcus. Proteus vulgaris. |
| 10. | Adenoma. | Large mononuclear cells seen in film preparation and a few finely granular polynuclear cells. | Staphylococcus albus.<br>,, aureus.<br>Intermediate coccus. |

## TABLE II (*continued*)

| *No. of Case.* | *Nature of Tumour.* | **Prostate.** | |
|---|---|---|---|
| | | *a. Cytological Examination of Exudate.* | *b. Bacteriological Examination of Exudate.* |
| 11. | Adenoma. | Ditto. | Staphylococcus albus.<br>„ aureus. |
| 12. | Spheroidal celled Carcinoma. | No milky fluid present. | Sterile. |
| 13. | Adenoma. | Small and large mononuclear cells seen. | Staphylococcus albus.<br>„ aureus.<br>Intermediate coccus. |
| 14. | Adenoma. | Finely granular polynuclear and mononuclear cells were numerous. | Staphylococcus albus. |

*The results of a bacteriological examination of the prostate gland and urine, which have been recorded in the above tables, are as follows:—*

## TABLE I

(Same cases.)

**Prostate Gland** :—

| | Cases. |
|---|---|
| Sterile | 3 |
| B. coli | 2 |
| B. coli and a diplococcus | 1 |
| B. coli and a streptococcus | 1 |
| Staphylococcus albus | 5 |
| Staphylococcus albus and a streptococcus | 1 |
| Staphylococcus albus and staphylococcus citreus | 1 |

**Urine** :—

| | Cases. |
|---|---|
| Sterile | 2 |
| B. coli | 6 |
| Staphylococcus albus | 5 |
| A diphtheroid bacillus | 1 |

## TABLE II

**Prostate Gland** :—

| | Cases. |
|---|---|
| Sterile | 4 |
| Staphylococcus albus | 3 |
| Staphylococcus albus and other cocci | 4 |
| B. coli and a diplococcus | 1 |
| A new pathogenic bacillus | 1 |
| A streptococcus and proteus vulgaris | 1 |

### THE PROSTATE GLAND

Film preparations of the turbid fluid which exudes on cutting into the large majority of enlarged prostate glands show in most instances a large number of finely granular polynuclear cells, and also large and small non-granular mononuclear cells. The large mononuclear cells usually show numerous coarse vacuoles. Masses of pavement epithelial cells are constantly present, and occasionally a very few coarsely granular eosinophils.[1] The milky appearance of the prostatic fluid is said to be due to innumerable refractile particles composed of lecithin. If film preparations are made of the fluid obtained from prostatic adenomata and stained with Scharlach R., it will be seen that a certain number of these particles consist of fat; the majority, however, will not react to the fat stains. In some instances, film preparations of the fluid have been made and fixed in formalin vapour before drying, and then stained for twenty-four hours with Scharlach R. On such occasions large and small fat droplets were seen in the large mononuclear cells and some of the finely granular polynuclear cells also contained fat droplets. A small proportion of large cells containing prominent granules which do not stain with Scharlach R. are always present. It is probable that these are vacuoles which originally contained fat, because clear spaces are seen in the majority of the cells which also contain fat droplets. In some instances, of course, the refractile granules, which are abundant in prostatic fluid and which are not fat, may have been taken into the interior of the cells, serving as an example of phagocytosis. Amyloid bodies are present without exception.

Micro-organisms were only seen in the stained film preparations of the prostatic fluid on three occasions. I have never seen any prostatic casts which resemble renal casts, and others appear to have obtained similar results, for, as Emerson says, 'We have asked those who have examined many hundreds of specimens, and they have never seen one.'[1]

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[1] See coloured plate.

The only instances in the present series in which I failed to obtain any of this milky fluid were in one case of carcinoma of the prostate, in one instance of an adenomatous growth, and in one example of a myo-fibromatous tumour. In the last mentioned case the gland was so hard that it could only be removed in fragments, and the pieces consisted of little more than fibro-muscular tissue (see Fig. 42).

One of the most interesting facts concerning the cytological study of the prostatic fluid is that there is nearly always present a fair proportion of finely granular polynuclear cells. These cells are only seen in very minute numbers in the connective-tissue framework of prostatic tumours, but are usually present among the débris in the gland spaces in large numbers. It appears from a study of numerous sections of enlarged prostates that the finely granular polynuclear cells are seldom seen beyond the limits of the basement membrane of the gland spaces, except in the region of the prostate adjoining the bladder or urethra. In all of the so-called prostatic adenomata, and also in the normal prostate glands of children and adults which I have examined, collections of lymphoid cells are present. In some instances these collections of cells occupied a large area of the sections, in other instances the exact opposite was met with. On the other hand, plasma cells, which are so commonly found in chronic inflammatory processes, are extremely scarce, often absent. Coarsely granular eosinophils are occasionally seen, but are always very few in number. Small or large giant cells have not been met with. In fact, there is very seldom much or any evidence of chronic inflammation. The collections of lymphoid cells already referred to are not confined to the prostate gland; the normal thyroid by no means rarely contains similar deposits, and adenomata of the thyroid also. These collections of lymphoid cells are met with in the prostate glands of young children, and are quite as well marked here as in the adenomatous tumours of elderly men. This is very strong evidence, therefore, that they are not in any way related to inflammatory processes.

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[1] C. P. Emerson, *Clinical Diagnosis*. J. B. Lippincott & Co., Philadelphia and London, 1906.

## BACTERIOLOGY

As soon as the tumour was removed it was sent to the laboratory, the surface was then smeared with a hot knife, and a small piece of the gland was cut out with sterile instruments and dropped into a culture tube. A culture was also obtained of the fluid already referred to. Sections of the tumour for bacteriological purposes were always made as far distant from the urethra as possible. Aerobic and anaerobic cultures were made in many instances, and in some cases blood-agar plates were inoculated with the prostatic fluid, but all attempts to isolate the gonococcus were unsuccessful. This is an important fact, owing to the view held by certain observers. It will be seen from the accompanying table that the staphylococcus albus was the commonest organism isolated from prostatic tumours (fourteen times), while the colon bacillus was isolated on five occasions. A new organism, which has already been described in the *Journal of Hygiene*,[1] was obtained in one case. This bacillus in a few respects resembled the ordinary type of colon bacillus, and in other ways the bacillus typhosus. It was highly pathogenic to guinea-pigs. It is quite certain that the presence of the colon bacillus in the urine has only a slight relationship to the presence of this organism in the prostate. The white staphylococci, which have been isolated in so many of these cases, have been subjected to a detailed investigation on the lines proposed by Mervyn Gordon, and the results will be published in full at some future date, but suffice it to state here that many strains of white staphylococci have been isolated which differ widely, but are all grouped together under the term staphylococcus albus.

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[1] Leonard S. Dudgeon, 'A new Pathogenic Bacillus isolated from the Prostate Gland,' *Journal of Hygiene*, July, 1906.

It may be of interest to refer to the presence of the micrococcus neoformans of Doyen in prostatic and other tumours. This organism was described by Doyen, in 1901, as occurring in simple and malignant tumours, and when inoculated into animals gave rise to neoplastic formations. Doyen specially advocated the use of a certain medium for the cultivation of this coccus, namely, 'bouillon de mamelle de vache.' I have not isolated this organism in any of the cases recorded here, but the special medium which Doyen recommended was never employed. This coccus, however, grows well on all the ordinary media,[1] and it is unnecessary to use the special medium which he suggested. Dr. Paine found the micrococcus neoformans present in eleven out of forty-four new growths which he examined, but there was no case of prostatic tumour amongst this series.[2]

## CONCLUSIONS

1. It appears from a bacteriological examination of tumours of the prostate that micro-organisms cause a certain amount of inflammation, which produces enlargement of the gland, but

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[1] Leonard S. Dudgeon and E. V. Dunkley, 'The Micrococcus Neoformans,' *Journal of Hygiene*, January, 1907.

[2] Alexander Paine and D. J. Morgan, 'Value of a Serum (Doyen's) in Cases of Malignant Disease,' *Med. Chir. Trans.*, 1906, vol. lxxxix.

bacterial infection is a secondary event, and similar to that which so often occurs in tumours elsewhere in the body.

2. That a bacteriological examination of the urine may throw little or no light on a similar examination of the prostate.

3. There is no evidence to support the view that enlargement of the prostate gland, such as is referred to in the text, is of a gonorrhoeal origin.

# CHAPTER VI

## ETIOLOGY

THE etiology of the enlargement of the prostate is still unsettled, and will most probably remain so until the causation of tumours in general is determined. From histological investigation there appear at the extremes two forms, viz. the glandular, forming enucleable tumours, and the fibro-muscular glandular, forming an enlargement which does not admit of enucleation, but these, though widely different in structure, seem to be linked together by intermediate forms.

Many theories have been advanced, some are based on what appear to be reasonable grounds, while others are founded on erroneous histological observations, or have at least a very small basis of solid fact. They may be enumerated as follows:—

1. That it is due to a senile fibrosis.
2. That it is due to sexual excess.
3. That it is due to ungratified sexual desire.
4. That it is due to an attempt on the part of nature to counteract the pouching of the bladder due to degeneration of the muscle.
5. That it is due to perverted action of the testes.
6. That it is a change normal to advancing years.
7. That it is due to a chronic inflammatory process.
8. That it is caused by a septic catarrhal process.
9. That it is a neoplasm.

It will be seen that some of these theories attempt to give a reason for the disease without any special reference to the nature of the enlargement, while others attempt to supply a reason for the enlargement and an explanation of the morbid histology. The first takes it for granted that the change is of a fibrous nature, whereas such a change is very rarely found. Nos. 2, 3, 4, 5, and 6 supply a reason for the enlargement without discussing the nature of the enlargement. Nos. 7, 8, and 9 are the theories which are best supported by facts, and will therefore be considered here. These latter, for the most part, admit the histological appearances described in Chapter IV, but differ as to the interpretation to be placed on these appearances and as to their actual nature.

*Theory* 7. This theory, for which Ciechanowski is largely responsible, states that the disease is due to a chronic inflammatory process affecting both stroma and gland epithelium, set up by organisms which have gained entrance to the gland at some antecedent date. It has been suggested that the gonococcus may be the infecting organism, but it is admitted that the proof of this is wanting. Whatever the agent may be, it is held that a chronic inflammatory process leads to cicatritial contraction of the stroma. The results differ according to the position in which this cicatritial contraction is most marked. If the disease attacks the circumferential portions of the organ, the contraction of the scar tissue causes atrophy of the glandular alveoli, with the result that a small hard atrophic prostate ensues. If, on the other hand, the contraction takes place near the urethra, that is in the neighbourhood of the gland ducts, these latter are constricted. This alone, it is held, would lead to a dilatation of the gland spaces, but its effects are enhanced by the inflammation found existent in the epithelium.

The difficulties of accepting this view of the causation of prostatic enlargement are as follows :—

The organism causing the chronic inflammation, if it be gonorrhoeal, must, from the history of many cases, have lain dormant many years. Many patients with enlarged prostates have had many children, and their wives have shown no signs of gonorrhoeal infection. If some other bacteria are considered to be the cause, it must be shown that those which are found in the enlarged prostate are capable of setting up such an inflammation.

In the case of the encapsuled tumours, it was shown on p. 71 that the appearances of the microscopic sections may differ but little from those of the normal prostate; the form of the alveoli, the plications of the wall, and the nature of the epithelium are all similar to those found in the normal gland. The chief differences are: some varying dilatation of the gland spaces combined with a flattening of the epithelium, or a shedding of the epithelium and the signs of a catarrhal inflammation. The stroma may be altered in quantity, but the normal constituents, viz. fibrous, muscular, and elastic tissue, are present. Nowhere are there any evidences of masses of fibrous tissue either in the making or in the perfect form.

The third reason against accepting the chronic inflammatory theory is to be found in the encapsulation of the tumours. This encapsulation is explained as taking place from the increase in size of the outlying portions of each alveolus, due to cystic dilatation, and to the tumours thus formed, because they are not believed to be true adenoma, the name pseudo-adenomata is given. If such encapsulation can take place as the result of a retention dilatation, such a process is confined to the prostate; cystic dilatation does not lead to encapsulation in other organs. The cysts in chronic interstitial mastitis, for instance, to which the prostatic process has been compared, certainly cannot be be shelled out.

Another objection to the obstruction hypothesis is again to be found in the want of proportion between the size of the tumour and the amount of dilatation of the gland spaces.

The normal transverse diameter of the prostate is 36 mm., and the vertical 30 mm. The measurements of the tumour shown in Fig. 60 were 9·5 cm. and 6·5 cm. respectively. The increase in size to be accounted for, therefore, may be very considerable. If such increase in size is simply due to cystic dilatation there should be some relation between the size of the tumours which are enucleated and the amount of dilatation present in the glandular spaces. As a matter of fact this relation does not obtain, and in some of the largest tumours the glandular alveoli are of normal size and show intra-alveolar processes, and the epithelium is unaltered, certainly not flattened. In the small tumours, on the other hand, which may not much exceed the normal prostate in bulk, cysts of such a size as to be easily recognized by the naked eye are frequently found. It may be said that it would be impossible to judge from the inspection of a series of microscopic sections whether the tumour from which they were taken was of a small or large size.

Even in the fibro-myomatous forms, evidences of a chronic inflammation are wanting. The glandular elements are atrophied, but appropriate stains always show large masses of muscle tissue even in those areas which appear by ordinary stains to be fibrous. In certain cases, indeed, the amount of muscle tissue in such specimens exceeds that of the fibrous. The areas of small round-celled-infiltration, which were supposed to be evidence of the commencement of a cicatrizing inflammation, have been shown to be of a non-inflammatory nature, and, what is more, to be present in normal prostates, and in the prostates of young children. The small round cells are lymphocytes, and the presence of groups in the normal gland may be viewed as representing foci of lymphatic tissue such as occur in most of the viscera.

*Theory* 8. This states that a catarrhal inflammation is set up by micro-organisms which gain entrance to the prostate from the urethra. The resulting inflammation causes a desquamation of the epithelium, with a consequent blocking of the lumen and the retention of the glandular products. In its favour may be quoted the fact, that the urethral mucous membrane is full of crypts and plications which would readily retain such organisms, and also the fact is shown on p. 85 that from most prostatic tumours micro-organisms can be cultivated, and that many glandular alveoli show signs of inflammation. Inflammation of bacterial origin is required to explain the enlargement, and this compels the assumption that a large proportion of bladders and urethrae are infected at some date antecedent to the commencement of the enlargement of the prostate, and that infection must have taken place between forty and fifty years of age, long before signs of prostatic enlargement were discerned, and before any catheter had been passed. Such an infection, moreover, must produce no symptoms in itself. This theory, like the last, depends upon cystic dilatation to account for an increase in the size of the organ, and for the encapsulation of the tumours. The difficulty of accepting this explanation as adequate is again encountered here.

*Theory* 9. The last view, which is largely held by the French school, attributes the enlargement of a prostate to a new growth. The cause of the new growth is as unexplained as that of new growths arising in other parts of the body, and may be due to an irritation, which may itself be due to micro-organisms. This is, however, totally different from saying that the enlargement of the organ is directly due to a chronic or acute inflammation. The facts in favour of the neoplastic origin of the growths are :—

(1) Presence in most cases of enucleable tumours.

(2) That microscopic sections of completely encapsuled tumours

are in many instances hardly distinguishable from the normal prostatic tissue as regards the shape and size of the glandular alveoli, and the proportion of muscular fibres and elastic tissue in the stroma. It is true that cysts are not uncommon, but such cysts are commonly met with in tumours which are universally admitted to be neoplasms, such, for instance, as the cystic fibro-adenomata of the breast. In fact, the tumours under question differ no more in structure from the normal prostate than do many other adenomata from their parent organ. Fibro-adenomata of the breast show a great variety in the relative amount of fibrous and glandular tissue, as well as in the amount of dilatation of their alveoli. It is thus easy to account for those cases in which tumours consisting almost entirely of gland tissue, on the one hand, and tumours almost entirely made up of stroma, are enucleated from the same prostate. Many tumours enucleated are compound in nature, that is, made up of small tumours which are themselves also enucleable. A parallel to this is found in the case of the thyroid, in which such compound tumours are also met with. Demonstration of the actual formation of new glandular alveoli has been as stoutly insisted on by some observers as it has been denied by others. The argument, it seems, is of very little value, and it is doubtful if such growth has ever been demonstrated in adenomata in other organs. It would certainly be extremely hard to say whether an alveolus is new-formed or belongs to the parent gland, since in adenomata the gland tissue must, from the nature of the growth, closely resemble the old stock, but the fact that in some greatly enlarged prostates the normal structure is maintained throughout proves that there must have been an overgrowth of the glandular tissue.

## CONCLUSION

The neoplastic theory accounts satisfactorily for the observed facts found in most cases of enlargement of the prostate. Those cases in which no enucleable tumours are produced, and in which gland tissue is for the most part wanting, offer a difficulty, but this difficulty cannot be surmounted by invoking a chronic inflammatory process, for the simple reason that there are no signs of such a process in histological sections. The presence of desquamated epithelial and of polymorpho-nuclear cells in the glandular alveoli is due to a secondary infection of a pre-existing tumour.

# CHAPTER VII

## DIAGNOSIS

### CLINICAL SYMPTOMS

It is no easy matter, on account of their insidious nature, to say with certainty when symptoms first appear. It is therefore equally difficult to make a definite statement as to the time at which the disease first starts; but it is fairly certain that a considerable interval must elapse between the onset of the disease and the appearance of the first symptom. Most patients come under treatment between the ages of sixty and seventy-five, and a good many between fifty and sixty. The disease is rare before fifty, and very rare before forty.

The enlargement gives rise to a train of symptoms which are usually painless until late in the disease, unless infection of the urinary tract or acute retention occurs. It is very necessary to distinguish between symptoms due to enlargement of the prostate and those due to enlargement of the prostate complicated by cystitis.

The patient at first, without perhaps being aware of it, passes urine at more frequent intervals, but in course of time he finds that he must make some arrangement in his daily routine so as to be in the position to micturate, should he feel the inclination. He has to choose a lavatory compartment in a train, and finds he cannot with comfort sit out a long theatrical performance or concert. In addition to this desire for frequent micturition, a difficulty of starting the act is noticed, and occasionally this is the first symptom to attract attention. There then comes a time when the patient has to rise at night to empty his bladder. At first this is only occasional, but it soon becomes a matter of routine. The calls to micturition become urgent, and must be quickly obeyed. The flow of urine is slow, weakly projected, and subject to intermission, while straining does not improve matters. Dribbling from the meatus often occurs after the act is apparently ended. The last phase is that of retention, and in a certain number of cases it persists. An attack of retention is occasionally, however, the first symptom; it may yield to treatment or remain permanent. Again, before the stage of retention is reached, the frequent micturition may become so distressing and sleep so interrupted that the aid of the catheter is sought.

Such are the usual symptoms, but they are not all met with in the same individual, either in the same order of occurrence or in like degree. Many patients never suffer from more than a little increased frequency, and die without being seriously incommoded by their trouble.

The symptoms will now be considered in more detail.

*Increased frequency of micturition.* This is usually the first symptom of the disease, and is at first so slight as to escape the patient's recognition, and its presence may only be elicited by careful questioning. Even when it occurs at night, provided it is not too frequent, but little notice will be taken, and it is only when sleep becomes seriously disturbed that advice is sought. The passage of a catheter before retiring to bed will usually give an undisturbed night's rest. The next phase commences when micturition becomes so frequent during the day that relief is sought by the passage of a catheter in the morning, and by this means the day is passed in comfort. A time may then come in which the calls to micturition are complicated by extreme urgency, and any delay in responding to the call causes much pain and even an involuntary passage of urine. Under these conditions the patient will often be found to practise self-catheterization at frequent intervals, and yet gain but little peace or freedom from discomfort.

*Loss of power of propulsion.* This is met with when the disease is fairly well marked. The urine is no longer expelled away from the body in a strong, steady stream. A voluntary muscular effort to remedy this condition is only partially successful. Later on, the power of projection becomes still more feeble or is lost, and the stream falls almost vertically to the ground, so that it soils the clothes or boots of the patient. In extreme cases the urine comes in drops and driblets, and voluntary effort, instead of improving matters, may only arrest the flow.

*Intermittent micturition.* By this is meant sudden arrest of the stream during the act of micturition, followed possibly after a moment or two by its re-establishment. This symptom is not a very frequent occurrence, but when met with it is usually somewhat late in the disease.

*Difficulty in starting micturition.* This may be the first, or at any rate an early symptom, but usually it attracts attention at a somewhat later period. The patient who has felt a desire to micturate finds that, when he has made all his preparations, the urine will not flow, and some minutes may even elapse before the urine is expelled. Such a patient will enter a urinal, make all his preparations, but before he has commenced to empty his bladder younger and more fortunate individuals will have entered, performed their business, and departed.

*Dribbling at the end of micturition.* This is a late symptom. When the act has apparently finished more urine is found to flow slowly from the meatus. This may happen almost immediately after the cessation of urination, and if so is not accompanied by any unpleasant results. In other cases it does not occur for an appreciable interval, and the patient may have adjusted his clothes and be on the point of proceeding on his way when urine again flows and soils his underclothes.

*Inability to completely empty the bladder.* Urine that remains in the bladder after a voluntary act of micturition is termed residual urine. About the time that nocturnal micturition becomes a feature in the disease, the passage of a catheter will show some amount of residual urine, but there does not seem to be any constant relation between the frequency of micturition and the quantity of such urine. The amount found varies within great limits. It may be only a few drachms, or amount to many ounces, in fact no line can be drawn between the state in which residual urine exists and retention begins. The presence of residual urine in itself produces no symptom except in so far as it causes the bladder to become more quickly distended. On the whole the tendency is for the amount to increase, yet many patients seek advice and are submitted to operation in whose cases it never reaches any considerable quantity. The mere existence of residual urine seems to produce little harm provided it is not so excessive as to cause an actual distension of the bladder wall. Should, however, the bladder become infected, the presence of residual urine is very serious. If cystitis develops, the bladder, provided it can get completely rid of foul urine and is helped by urinary antiseptics, can overcome the disease and return to a healthy state; but if the organ cannot totally expel its foul contents, it has difficulty, even if helped by drugs, in taking on a healthy action, since the urine secreted by the kidneys in the intervals of micturition, will at once become infected by the urine remaining after the last act of expulsion.

*Retention.* As was stated in the general view of the symptoms, retention may be the first symptom noticed by the patient, or it may be the last of a long train of symptoms. When once it has occurred it may remain permanent, or it may pass off and not recur for a number of years, or it may yield to treatment to appear again at more and more frequent intervals. The physical signs of retention are, as a rule, obvious enough, but the subjective symptoms may be very slight, and a distended bladder may be found when least suspected by the patient.

It is usual to draw a distinction between a state in which residual urine exists and that of retention, and to a certain degree this distinction is just. One patient may, after micturition, have 16 ounces of urine still remaining in his bladder, which urine would by one observer be called residual. In another case the bladder by palpation is found to form a fair-sized abdominal tumour, although the patient makes no complaint that he is unable to pass his urine. Such a condition would be called by some an incomplete retention. On the other hand, all observers would diagnose retention in a case of a patient who came complaining of great pain and great desire, but of inability to pass his urine. A distinction is sometimes drawn by saying, that the presence of residual urine is the result of inability of the bladder to empty itself, though it can expel a certain amount of its contents, while retention consists in a total inability to get rid of any urine by a voluntary effort.

*Incontinence.* In speaking of incontinence it is necessary to be careful to define what is meant by the term. If by incontinence is meant paralysis of the sphincter muscles, so that the bladder is unable to retain any urine, then incontinence of urine in prostatic enlargement must be very rare indeed. If, on the contrary, constant and almost involuntary passage of small quantities of urine is understood, then incontinence is not uncommon. This condition is tantamount to a frequent micturition in which the impulse is so great that it can hardly be controlled by the will, and is most commonly met with after infection of the urinary tract.

*Overflow.* This term should be reserved for that condition of unrelieved retention in which urine dribbles away as a result of over-distention of the bladder. Muscular contraction is not involved in the act. It is a passive escape of urine favoured by the patulous condition of the internal meatus, and is not of frequent occurrence.

*Micturition in unusual postures.* It is found by some patients that, while they are unable to micturate standing, success attends their efforts when they place themselves in the knee-elbow position.

*Pain.* This is not a prominent symptom unless some complication is present. There may be a sense of weight or uneasiness in the perineum, but this rarely amounts to pain. There is no doubt that the prostatic enlargement produces a feeling of ill-defined discomfort, and some patients after prostatectomy remark, that they are conscious of a sense of lightness and well being about the urinary apparatus, which is in pleasing contrast to their sensations before the operation. Occasionally there is painful urethral spasm associated with the desire for micturition. In some cases patients complain of pain in the hypogastrium, back, penis, or urethra. At other times it is felt in the thighs, sometimes in the course of sciatic nerves. Pain in the lower extremities is rare in simple prostatic enlargement, and if severe its presence should raise a suspicion of carcinoma. Calculus, again, will produce its own particular train of symptoms, and patients may seek relief on account of such symptoms. On the other hand, it is not unusual to find a stone or stones when operating for prostatic enlargement, the presence of which had given rise to no trouble whatever. If the bladder becomes infected, both pain and frequency of micturition are increased, and the patient's condition undergoes a change for the worse.

*Haemorrhage.* Many patients pass through all the stages of prostatic enlargement and never suffer from haematuria. In a few cases, spontaneous haemorrhages outweigh all other symptoms and produce a profound anaemia.

When the haematuria occurs spontaneously, the blood may be mixed with the urine in greater or less amount, or it may appear at the end of micturition, or be the only result of an attempt at micturition, or be altogether unconnected with the act. Occasional haemorrhage takes place into the bladder in such amount as to fill the viscus and clot in situ, so that a supra-pubic cystotomy is necessary for its removal.

It may be frequent or only occur at rare intervals. The attacks may be of short duration or last several days. Haemorrhage often follows the passage of a catheter, and that without undue violence being used. Its repeated occurrence, whether it be spontaneous or the result of catheterization, is of grave moment, and is a sign that active measures must be taken for its relief.

It is usually held that spontaneous haemorrhage is more frequent in carcinoma than in other forms of prostatic enlargement, and that, therefore, haematuria is in itself suggestive of carcinoma. It is doubtful whether this is really the case, and I am inclined to think that haematuria is not frequently found in malignant disease of the prostate. It may certainly be said that its absence does not contra-indicate carcinoma.

*Rectal symptoms.* These are seldom prominent. Pain or difficulty on defaecation are infrequent, but sometimes there is a sense of dissatisfaction after completion of the act. Haemorrhoids or prolapse are occasionally seen. A most distressing though not frequent symptom is an inability to prevent a partial evacuation of the rectum when the urine is voided. This will occur even when the bowels are in a normal state, but becomes intolerable when they are loose.

### COMPLICATIONS

*Bacterial invasion.* This may take place when the urine is either acid or alkaline. In eleven cases, in which the reaction of the urine was tested and a bacteriological examination made, the results were as follows :—

| | | | |
|---|---|---|---|
| Urine, acid, 8 cases | Bact. coli com. 4 | Staphyl. coc. alb. 2 | Sterile, 2. |
| ,, alkaline, 2 cases | ,, ,, ,, 1 | ,, ,, ,, 1 | |
| Th. neutral, 1 case | Diphtheroid bac. 1 | | |

The above cases were chosen because there was no gross infection of the genito-urinary tract. They therefore throw no light on the bacteriology of marked septic cystitis.

*Alkaline cystitis.* This is due to organisms introduced by the catheter, and must on that account be looked on as a failure of treatment.

It differs in no way from the cystitis observed in other conditions. In the slighter cases the mucous membrane is inflamed; in the severer ones there is intense congestion, ulceration, or sloughing. The alteration in the reaction of the urine leads to the formation of phosphatic stones or the deposition of phosphatic incrustations. Long continuance produces, it is said, a fibrous degeneration of the muscle fibres of the bladder wall. Prostatic patients with foul urine often seem to acquire a certain amount of immunity, and may for a long time keep in good health. Sooner or later the infection spreads to the kidneys and a septic pyelitis results, or an acute interstitial nephritis is engrafted on to changes already produced by the difficulties of micturition.

An alkaline cystitis is responsible for most of the pain suffered by those afflicted with enlargement of the prostate. The frequency of micturition is increased, and to this is added dysuria, extreme urgency, or loss of control. In extreme cases the condition of the patient is almost insupportable. Urine is continually passed in small quantities, and its passage accompanied with pain and spasm. The act of micturition gives little or no relief, and is quickly followed by another desire to pass water. The urgency or loss of control leads to soiling of the clothes, and the sufferer gives off an ammoniacal odour. The nights are disturbed, and the patient grows thin and worn out from loss of sleep. When the kidneys are involved, the state of the patient is further aggravated. He suffers from pain in the loins and back. The complexion becomes sallow, the appetite poor, the tongue dry and coated, the temperature raised, the pulse rapid, and a fatal issue is the rule.

*Acid cystitis.* This is usually caused by the bacillus coli communi. Infection probably takes place from the bowel or the rectum ; it certainly occurs before the introduction of a catheter. No suspicion of infection may arise unless a bacteriological examination is made. The urine is often clear, but in some cases becomes milky, or shows a sediment on standing. Symptoms are frequently absent or amount to nothing more than a little increased frequency of micturition. At other times the acts of micturition become as frequent as in the alkaline form. Although a wide-spread infection of the urinary tract, accompanied with fever and signs of septic absorption, may take place with a pure infection of this organism, the greatest devastation is wrought when an alkaline cystitis is engrafted on the acid.

*Inflammation of the prostate.* In the light of Herring's and Daniel's experiments, and of Dudgeon's cultivations, it is surprising that the enlarged prostate does not more often show signs of inflammation. The author has never seen a case of enlarged prostate which showed local signs of pain and tenderness such as are seen in acute prostatitis, nor has he seen any evidence of such a condition after death.

*Epididymitis.* This is a fairly common complication when infection of the bladder has taken place. With some patients it is the constant repetition of this affection which causes them to seek advice. It is also met with in the course of healing after prostatectomy. The inflammation may subside or go on to the formation of an abscess. The clinical symptoms are those usually met with in the disease, and call for no special notice.

*Vesical calculus.* The usual symptoms are present or are altogether absent, and the calculi only found at the operation.

*Vesical carcinoma.* This is a rare complication. Its possibility should however be borne in mind, since such a complication must very materially influence the treatment. The symptoms may be entirely latent, or there may be haemorrhage. If this latter occur in a prostatic patient between the ages of fifty and sixty it is well to make sure that the cause is not a bladder growth.

## PHYSICAL BASIS OF THE CLINICAL PHENOMENA

Opinions have differed as to the situation of the true sphincter of the bladder, and as to the muscle or muscles which form it. Some hold that the collection of muscle around the internal meatus forms the sphincter, which is therefore called the internal sphincter. Others maintain that the constrictor urethrae really forms the true sphincter. According to this latter theory, the internal sphincter is only able to withstand a very small pressure, and the prostatic urethra is taken up into the cavity of the bladder as this latter organ becomes distended. The urine is retained by the action of the constrictor urethrae, and an act of micturition is begun by the entrance of urine into the membranous urethra caused by a relaxation of this muscle. Under these conditions a striped voluntary muscle plays the part of a sphincter.

According to those who hold that the muscle around the internal meatus is the sphincter muscle, the act of micturition is initiated by the entrance of urine into the prostatic urethra, caused by a passive dilatation or a relaxation of the internal sphincter, following a desire to void urine brought about by a distention of the bladder. Under these circumstances an unstriped muscle constitutes the sphincter. The remainder of the act is the same under both theories.

It is unnecessary here to review all the arguments for or against one sphincter or the other. The matter seems to have been definitely set at rest in a paper by Leedham Green (*Brit. Med. Journ.*, August 11, 1906), in which, by means of skiagrams taken of bladders which had been distended with a suspension of bismuth, he clearly showed that no taking up of the prostatic urethra into the bladder occurred when this organ became distended, nor did any of the fluid enter the prostatic urethra while the bladder was at rest. It would therefore appear from these experiments that the internal sphincter is the true sphincter, and that it remains closed until it is dilated or relaxes in response to a nervous impulse.[1]

It is necessary here to mention an observation made by Thompson Walker on the condition of a bladder examined post mortem sometime after the performance of a supra-pubic prostatectomy. In this case it was stated that the cavity left by the removal of the tumour still persisted, though reduced in size.

The presence of this cavity was taken as showing that the internal sphincter was still dilated, and therefore functionless.

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[1] More light has been thrown on this subject by C. Arthur Ball in a paper in *The Practitioner*, March, 1907.

From this it was argued that, as micturition had been normal since the operation, the closure of the normal bladder must lie in some structure distal to the prostate. If the deductions are right, this case would support the theory that the constrictor urethrae is the true sphincter of the bladder.

*Increased frequency of micturition.* It is usual to attribute this phenomenon to a congested and irritable condition of the vesical mucous membrane, and to the presence of residual urine. Frequent micturition is certainly present in cases where there is no residual urine. The latter cannot therefore be said to cause the former, though it may aggravate it. An irritable state of the mucous membrane is certainly brought about by cystitis, but cystitis is not to be found in every case of frequent micturition. It is also difficult to believe that congestion is present in every case at the very early period at which frequency of micturition occurs. From our own experience of the state of the mucous membrane in advanced cases of prostatic enlargement submitted to operation, it would appear that congestion is not even then a common condition. Some other causation must therefore be sought, and although it is not claimed that anything like a complete explanation can be given, the following suggestions are, it is believed, worthy of consideration :—

The bladder is normally closed by the internal sphincter which lies immediately under the mucous membrane. In the chapter on the morbid anatomy it was explained that one of the earlier changes is a thinning and stretching of the internal sphincter (see Fig. 28). The next stage is a dilatation and thrusting aside of the muscle ring by the invading prostatic growth. The last stage is the appearance of a cone-shaped projection with a patulous meatus. It is suggested that the frequency of micturition begins at the time when the sphincter, owing to its thinning, commences to act at a disadvantage, and can only with difficulty keep the urine from entering the urethra. In the most advanced cases, the urethra, which opens on the top of the intra-vesical one,

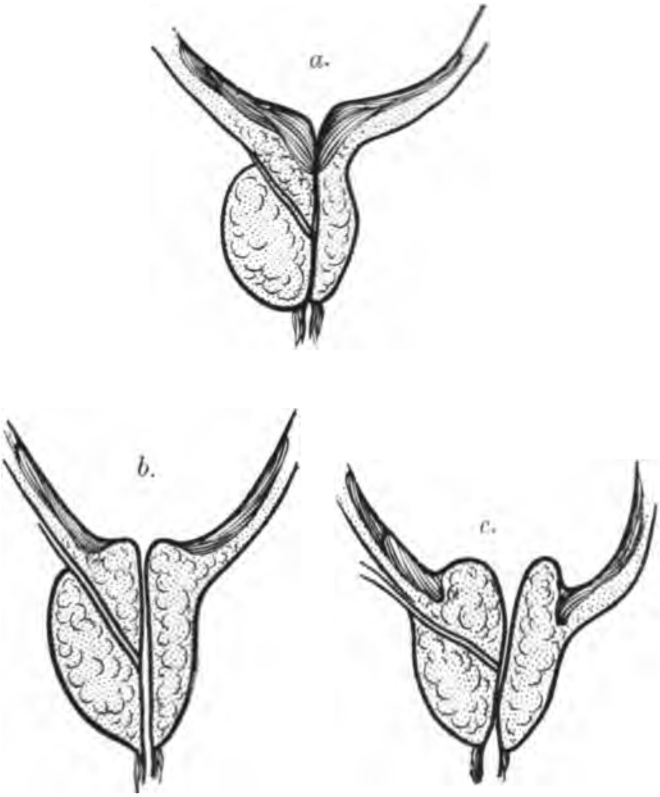

FIG. 44.[1] *a.* The prostate is entirely extra-vesical. The internal meatus is completely surrounded by muscle fibre. *b.* The prostatic gland tissue has insinuated itself into the sphincter, so that the internal meatus is surrounded by prostatic instead of muscular tissue. Although the sphincter vesicae is stretched, the floor of the bladder presents but little departure from the normal when viewed from the interior. *c.* The prostate has now formed a distinct intra-vesical projection, which may be compared to the projection of the uterus into the vagina. The sphincter is widely separated; the internal meatus is patent, and surrounded by gland tissue.

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[1] I am indebted to *The Practitioner* for the use of this block.

is so patulous as to admit the index finger, while the sphincter lies at the base of the cone, widely separated by the new growth from the urethral canal proper, and is itself so stretched as to be practically worthless. It seems to be easy under such conditions to explain the frequency of micturition even when the bladder is so little filled with urine that distension could hardly be relied upon to produce a desire for micturition.

The presence of residual urine no doubt aggravates the symptoms, since the continual secretion of urine into an imperfectly emptied organ causes the vesical pressure to increase more rapidly than in the case of an organ that can entirely rid itself of its contents. Another factor may be the presence of the intravesical projection itself. Such a projection may well call forth an attempt at micturition, much in the same way that a small polyp in the rectum causes tenesmus or the desire to defaecate.

*Difficult and intermittent micturition.* This may consist of a hesitation in starting the act, the loss of proper propulsion, or the sudden arrest of the stream. Failure of the muscular power of the bladder is no doubt a late contributing factor, but other conditions must be present to cause such a failure, and it is with these that we are concerned at present.

The distortion of the urethra either in an antero-posterior or a lateral direction, combined with the increased length of the canal, impedes the passage of urine, and this is aggravated by the increased tension in the middle portion of the prostatic canal produced by the pressure exerted by the growing adenomata. That there is a very considerable pressure on such tumours will be admitted by any one who has noticed the rapid contraction of the cavity left by their removal.

The growth of the adenomata will have another effect on the canal. Surrounded as it is by new growth, the muscular character of its wall is lost, so that this portion of the urethra becomes a passive segment lying between the bladder and the distal urethra.

When the distortion of the urethra takes the form shown in Fig. 45, which is a diagrammatic representation of the arrangement of the parts seen in Fig. 30, another factor is introduced which also causes a difficulty of urination, and especially that phenomenon known as intermittent micturition. It will be seen that, by the pushing forward of the internal meatus and upper part of the prostatic urethra, a valvular condition has been produced.

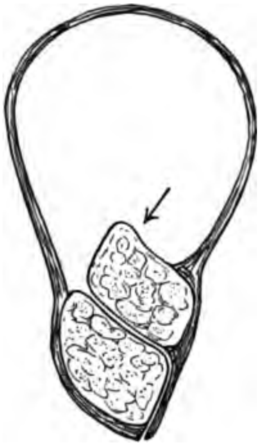

FIG. 45. Shows valvular nature of the internal meatus.

The patency of the internal meatus admits urine to the urethra, but directly the bladder begins to contract, the hydrostatic pressure forces the upper adenomatous mass down upon the lower. This movement not only closes the meatus, but also the upper portion of the prostatic urethra. If the meatus and urethra are not actually closed they are certainly likely to be obstructed. If the bladder relaxes, the urine will once more enter the canal, only to be again stopped in this same manner. Any voluntary contraction of the abdominal muscles can only make matters worse.

This particular distortion is usually caused by the 'ring' or the 'horse-shoe' type of tumour (see p. 185), but is also produced by the 'twin' tumour if one of the lateral adenoma sends out a medium process behind the urethra. A pedunculated adenoma situated on the edge of the meatus would have a similar effect, whether it lay behind or at the sides of the meatus, but such a growth is, in the experience of the writer, very uncommon.

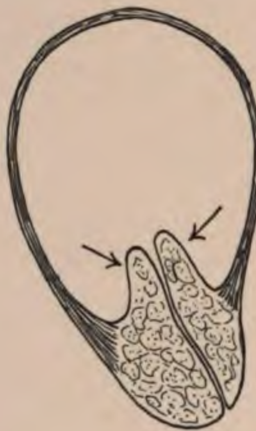

FIG. 46. Shows a valvular internal meatus caused by a well-marked intra-vesical projection.

When the internal vesical projection is well marked, and especially if it forms an acute cone, a similar effect may be produced. This can easily be appreciated in the accompanying diagram.

The urethra is here patulous, and its walls, formed by the projecting prostate, are flaccid. Urine can easily escape into the urethra through the open internal meatus. The bladder contractions will, however, exert a pressure on the outside of the cone which may in some cases be sufficient to close the opening and arrest the outflow. Here, as in the last case, voluntary expulsive efforts can only make things worse.

*Dribbling at the end of micturition.* The interposition of a long non-muscular section, as explained in the last section, would, it can be supposed, interfere with the co-ordinated muscle wave which is necessary for the complete emptying of the urethra.

It seems probable that dribbling is due to the absence or interruption of the normal muscle wave, whereby the urethra is, under normal circumstances, emptied.

*Residual urine.* Failure of the bladder to completely obliterate its cavity results in the phenomenon of 'residual urine'. The reason why the bladder does not properly perform its function is not quite clear. Probably several causes are at work. Residual urine is only found after the prostatic disease has been established for some considerable period, and from this it can be argued that the pathological changes in the prostate must be well marked, and have had time to produce a distinct effect on the urinary apparatus. Enlargement of the prostate produces an obstruction to the outflow of urine which has been explained when speaking of the causation of difficult and intermittent urination. Such obstruction might in itself prevent a complete expulsion of urine. There are also other ways in which the alterations at the internal meatus might result in permitting residual urine to collect.

In the normal state, the bladder, in the process of obliterating its cavity, assumes an erect form, contracting itself on to a vertical axis passing through the internal meatus. The muscle coats all spring from a small area on the base of the prostate, so that a contraction can effectively obliterate its cavity, even at the lowest portion of the viscus.

When the prostate is enlarged, the muscle coats spring from the circumference of the enlarged organ (see Fig. 28), so that obliteration of the cavity is difficult or impossible.

The intra-vesical projection and the elevation of the internal meatus above the floor of the bladder will possibly, in addition, prevent a complete evacuation of the cavity. The bladder coats in consequence of the obstruction become hypertrophied, but continual effort may, in the long run, produce a deterioration in the muscle fibres, which will lead to an incomplete contraction. It is possible to believe that such muscle fibres, when stretched to a moderate amount, may be able to overcome considerable resistance, but are unable to maintain a powerful contraction when they have already considerably shortened their length. Over distension, whether habitual or occasional, will also lead to muscular failure.

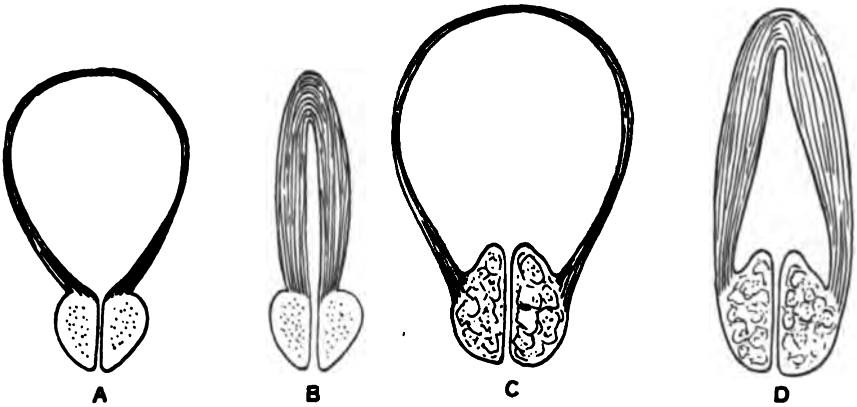

FIG. 47. Shows the difficulty, which the bladder encounters, of obliterating its cavity where the prostate is enlarged.

To recapitulate: the accumulation of residual urine is caused by the increasing difficulty in expelling the urine, brought about by the anatomical alteration of the parts surrounding the internal meatus, and possibly increased by a deterioration of the muscle fibre of the bladder wall.

*Retention.* The factors producing difficulty in micturition, intermittent micturition, and the collection of residual urine will, in an aggravated form, cause retention. It is usually supposed that congestion produces the final occlusion of the canal, and it may well be the cause of an acute retention, but can hardly be invoked to explain the continuance of the symptoms. The explanation of retention when it is the first symptom is by no means clear. Congestion can, one may believe, cause a retention which passes off, but it cannot explain an early retention which remains permanent. In such cases it would appear probable that symptoms, and therefore pathological changes, have been present for some time, but have not attracted the patient's notice. It is by no means uncommon for the patient to admit that, before the retention came on, he was in the habit of rising at night to empty his bladder. There is also no doubt that an enlarged prostate may vary in size from time to time, as shown by the fact that rest in bed, attention to diet, and the exhibition of urinary antiseptics, may have a very beneficial effect on the urinary symptoms.

*Haematuria.* Haemorrhage, when it occurs, must have its origin either in the mucous membrane of the bladder or of the urethra. It may occur quite independently of any inflammatory trouble. Examination of the mucous membrane overlying the prostate would suggest, that the bleeding arises from small vessels rather than from large veins, which according to the author's experience must be very seldom met with. The mucous membrane within the urethral canal is nearly always stretched and exceedingly thin, and it would appear from this fact that the bleeding is more likely to come from the bladder than from the urethra.

## PHYSICAL EXAMINATION

### THE PROSTATE

The prostate from its situation is not an easy organ to examine, and when all methods have been used, our knowledge of its size, shape, and the nature of the enlargement is still liable to be defective, and the impression gained by clinical examination may have to be altered in the course of an operative procedure.

1. *Rectal examination.* This is the most accessible route, and the one usually adopted. Steps should be taken to ensure an empty bladder, otherwise an erroneous impression may be produced by the pushing backward of the prostate. The patient should be placed in the knee-elbow position and the thighs slightly separated. The finger is introduced into the rectum with the pulp of the finger directed downwards. The apex of the prostate, in a normal subject, is felt immediately above the internal sphincter, that is, at the recto-urethral angle, 1¼ inches from the anal margin. If the finger is still further introduced it will pass on to the rectal or posterior surface of the organ. This surface is triangular in outline, the base being directed upwards (anatomically) and the apex downwards. It is smooth and flat, and the consistence is firm. The upper margin can easily be reached by the finger, and above it can be felt the softer posterior surface of the bladder, where this organ abuts on the rectum. This upper border appears slightly V-shaped, the apex of the V corresponding to its mid point. The upper border of the prostate is actually a straight line, but a V-shaped contour felt by the examining finger is due to the presence, above this border, of the vesiculae seminales and vasa deferentia as they pass out from the mid-line. The vesiculae seminales increase in breadth as they diverge, and since they are tightly bound down to this border of the

prostate, the examining finger, unable to make out the line of separation, gains the impression that the posterior surface of the prostate is cordiform or presents a notch in its superior border. The lateral margins of the organ cannot be easily defined, since they are obscured by the pelvic fascia stretching across in front of the rectum, the finger passing out from the mid-line of the prostate to the pelvic wall without perceiving any distinct lateral margin.

When an enlargement of the prostate has taken place the vertical extent of the posterior surface is increased, so that the examining finger may have a difficulty in reaching, or fail to reach, the rectal surface of the bladder. In addition, the rectal aspect is so altered that the finger, instead of passing on to a flat surface, encounters a bulging backward of the anterior wall of the bowel. This bulging may be so large as to cause some difficulty in gaining the point of maximum projection, the finger having to pass back into the hollow of the sacrum to do so. If the finger be carried to the right or left, it will enter a narrow angle formed by the projecting prostate and the lateral wall of the pelvis. The rectum has now a crescentic outline on cross section, the horns of the crescent pointing forwards. It has been shown that a prostate which is but little enlarged may contain well-marked adenomata producing distortion of the urethra. It consequently follows, that an absence of enlargement, as found by rectal examination, does not negative gross pathological change if other symptoms point in that direction. The consistence is usually altered in the direction of softness. A large tense prostate is generally of the glandular variety, and as such is likely to contain enucleable tumours. The larger and softer the prostate appears on rectal examination the better is the prognosis as regards feasibility of removal. On the other hand, firmness in a large prostate, if not accompanied by fixation or nodularity, is not to be regarded as an unfavourable sign. An increase in firmness in a slightly enlarged organ points, as a rule, to the non-uncapsuled variety of growth and to a difficult operation, while nodularity of the rectal surface, especially if added to fixation, is to be regarded as suspicious of carcinoma.

2. *Bimanual examination.* This method of examination is only available in thin subjects, and usually an anaesthetic is required. The patient is placed on his back, the finger introduced into the rectum with the pulp forward. The other hand is placed on the abdomen just above the pubes. If good relaxation of the abdominal muscles is obtained it is often possible to gain a very clear idea of the size, consistence, and outline of the enlarged organ. By the introduction of a sound into the bladder while the finger is still in the rectum, a useful knowledge of the absence or presence of prostatic adenomata lying behind the urethra, can be gained.

3. *Examination by catheter.* The catheter will reveal—

(*a*) A distortion of the urethra.
(*b*) An alteration in the length of the urethra.
(*c*) The presence of residual urine.

(*a*) An antero-posterior distortion is the most common, and in this case the catheter meets with an obstruction somewhere about the entrance of the ejaculatory ducts, since it is at this point that the increase in the normal angle of the prostatic urethra takes place. If this distortion is slight the catheter may, by a little extra pressure or by depression of the handle, if the instrument is a rigid one, slip on and enter the bladder after meeting with a certain amount of resistance. At other times the angle formed by the two portions of the prostatic urethra is a right angle (see Fig. 30), and in this case the catheter is likely to be permanently arrested. It is to overcome such an obstruction that the Coudé catheter is useful, and the character of the obstruction explains the fact that a soft red rubber catheter will enter the bladder when a rigid instrument is arrested.

Lateral distortion of the urethra is not commonly met with, and is shown to exist by the tendency of a rigid instrument to rotate to one side or the other.

(*b*) *Increase in length.* When the enlargement is extra or intra-vesical, the internal meatus lies at a greater distance than normal from the external meatus. The catheter, therefore, will have to be introduced further than usual before the eye enters the bladder and, therefore, before the urine flows in any quantity.

The increase in the length of the urethra takes place between the triangular ligament and the internal meatus. This portion of the urethra is that which is traversed by the beak of a rigid instrument. It therefore follows that a greater depression than normal of the catheter shaft is required, and in some cases the beak is too short to allow of its passage into the bladder, no matter what the depression of the handle may be. It was on this account that the long-beaked prostatic catheter was devised.

(*c*) *Residual urine.* The patient passes urine, and after the act is ended the catheter is introduced. If urine is drawn off, then that urine is termed residual. It may be, that owing to the intra-vesical projection, the catheter will be unable to completely empty the bladder, and the residual urine may actually exceed in amount that drawn off. The quantity of residual urine may be a few drachms, or a pint or more.

4. *The cystoscope.* There are cases where, owing to the distortion of the urethra, the cystoscope cannot be introduced into the bladder, and others where, owing to the difficulties of introduction and the state of the urinary function, it is not advisable to persevere in or even to make the effort. When the instrument has been passed, it often happens that little or no information can be gleaned, since the growth may have produced

little or no alteration in the bladder. If the projection is slight but irregular, its form may possibly be made out. Should the projection be large and uniform, there is difficulty in arriving at a just estimate of its height, since it lies immediately around the internal meatus. The ability or inability to see the upper edge of the trigone or the mouths of the ureters, may give some indication of the extent of the intravesical growth. Even if no definite view can be obtained of the prostate, some knowledge of the shape of the growth at the internal meatus may be determined. If the cystoscope is introduced with the window forwards, and the point noted at which the edge of the internal meatus is first seen, the distance of the anterior margin of the internal meatus from the exterior can be measured on the stem of the instrument. If this process is repeated, gradually turning the cystoscope round on its long axis, a very good picture can be obtained of the inequalities of the projecting prostate: thus, if the urethral margin is first noted on the posterior side when the cystoscope is introduced 8 in., while on the opposite side it is noted at 7 in., it shows that the prostate on the former side is projecting 1 in. further into the bladder than on the latter.

## EXAMINATION OF THE BLADDER

The size of the bladder may be determined by measuring the amount of fluid which can be injected without causing discomfort to the patient. In some cases, there is little departure from the normal, while in those cases in which the bladder has been habitually over-distended, the amount of fluid tolerated may be far in excess of the normal. In other cases the amount of fluid that can be borne is very much below the average, and this is especially likely to be the case when the bladder is the seat of an acute inflammation. As regards the thickness of the bladder wall, it may be said that the small irritable bladder is likely to have thick and hypertrophied muscle coats with well-marked fasciculation, while the bladder which tolerates a large quantity of fluid is usually comparatively thin, but almost invariably shows signs of fasciculation, and therefore of a previous hypertrophy of the muscle coat. Again, the state of the muscle fibre is shown by the force with which injected fluid is expelled. Those bladders which have been habitually over-distended, and more especially if they have been the seat of inflammation, are apt to exhibit very little muscular tone and to expel their contents very slowly even through a catheter. The same amount of importance is not now attached to the state of the bladder muscle as was formerly the case. It has been shown by Freyer that recovery of muscle tone is almost invariably the case when the cause of the obstruction has been removed.

By means of the cystoscope the amount of fasciculation of the muscle and pouching of the mucous membrane may be seen. Calculi may be detected, though from the contour of the prostate they are apt to escape detection. It cannot be said that the information thus gained is likely in any way to modify the treatment when once the diagnosis of enlarged prostate has been made.

Carcinoma of the prostate remains for a long time within the gland and would not be detected in the early stages, and only when it has invaded the bladder would it reveal itself to the cystoscope.

There is, however, a complication that must not be lost sight of, namely, carcinoma of the bladder. Such a complication of enlargement of the prostate has been met with by the author in two cases. In one the growth was small, and was removed when prostatectomy was performed. In the other the growth was too extensive for removal, and the only treatment adopted was a supra-pubic cystostomy.

## THE URINE

The urine, in those cases in which the catheter has not been used, or in which great care has been taken to prevent infection, is usually acid. On the other hand, in those cases in which the catheter has been habitually employed, the urine is often alkaline. It is quite true that a certain immunity is exhibited by those patients who have suffered from cystitis for long periods, but there can be no doubt that those cases in which the urine is acid are more favourable for operative treatment than those in which it is foul and alkaline. It does not follow because the urine is acid that there is no infection of the urinary tract; indeed, a most persistent cystitis, and one that is very hard to treat, is the acid cystitis due to bacterium coli commune.

Experience shows that such infection does not generally interfere with the course of healing after prostatectomy, and it is therefore no contra-indication to operation unless constitutional symptoms are present.

Pus cells in an alkaline or acid urine point to cystitis, and for this reason, especially if the urine is alkaline, to the possible necessity of a period of supra-pubic drainage before proceeding to prostatectomy. Fatty or epithelial casts are of much graver import than pus cells or albumen, as indicating gross disease of the kidneys. Such changes may be secondary to the prostatic trouble, or may arise independently. It is difficult to say how far their presence should modify the treatment, but the gravity of the case would be increased if gross arterial disease were present at the same time. It is to be hoped that the prospect of a successful operation will in the future induce patients whose kidneys are still healthy to seek relief by surgical means.

Whether sugar in the urine is a bar to operation, will depend on the opinion of the operator as to the general advisability of surgical interference in this class of case, and the line of treatment will be determined by the same considerations that govern operations in other parts of the body under the same conditions.

A bacteriological examination of the urine is desirable. If the bacterium coli commune is found and the signs of septic absorption are present, a preliminary treatment with a coli serum or vaccine is indicated.

## THE KIDNEYS

The state of the renal function must be largely judged from the state of the urine. Palpation may give but little knowledge as to the condition of the kidneys. An enlargement of the organ may be due to hydro-nephrosis, but the amount of dilatation is not usually sufficient to attract attention. Hydronephrosis need not contra-indicate operation if the state of the urine is otherwise satisfactory. An enlarged and tender organ must, however, be regarded with suspicion, since it points to a more or less acute infection. Prostatectomy is too dangerous under such conditions, and treatment must be confined to urinary antiseptics, rest in bed, and at the most to supra-pubic drainage.

## GENERAL CONDITION OF THE PATIENT

The general condition of the patient should be carefully considered. A patient who is thin, anaemic, and sallow, is to be regarded with suspicion. The state of the lungs is especially important. The chance of the recovery of many patients is gravely compromised by post-operative bronchitis, and it is possible that lung complications are the cause of death as often as operation, shock, or septic infection.

# CHAPTER VIII

## TREATMENT

### GENERAL TREATMENT

Our present knowledge does not permit of prophylaxis. The symptoms being largely due to alterations in the anatomy of the parts, it is not to be expected that drugs would have any marked effect. Care should be taken that the patient be not compelled to hold his urine for long periods when once the desire for micturition has occurred, since such compulsion not infrequently leads to an attack of retention.

Attention must be directed towards keeping the urine in a normal state, and avoiding anything likely to lead to congestion of the prostate or the mucous membrane of the urethra.

Concentration or hyperacidity of the urine is apt to aggravate the symptoms. Prostatic patients who suffer from frequency of micturition often attempt to lessen this symptom by restriction of the fluid ingested. This manœuvre, by raising the proportions of the solids in the urine, often defeats its own purpose. On the other hand, an increase in the amount of fluid taken, combined with citrate of potash and tincture of hyoscyamus, will often decrease the frequency of micturition. Sandal-wood oil, cubebs, and copaiba are recommended as being useful in reducing the irritability of the bladder. Alkalinity of the urine seldom occurs without infection of the bladder, and will be referred to when speaking of cystitis. Diet must be simple, exercise taken in moderation, and the bowels regulated. Clothing should be warm and light, and chills carefully avoided.

### PALLIATIVE TREATMENT

This consists in overcoming by artificial means the difficulties of micturition, and in relieving the complications, such as cystitis, retention, and haemorrhage, as they arise. Without discussing at present the probability of the abandonment of the catheter, it will be useful to consider the present practice. Patients resort to the catheter to diminish the nocturnal calls to micturition, and it is at this time that residual urine is usually first found. At first the passage of a catheter before retiring to rest ensures a good night without disturbance. In process of time, to prevent the frequency of micturition becoming too troublesome during the day, catheterization is required in the morning. Later on this is found insufficient, and a catheter must be passed at varying intervals until bedtime. When the patient is no longer able to void urine, and retention becomes complete, a catheter must be passed at least three times in the twenty-four hours.

When catheter life is commenced most patients have to learn to pass the instrument, and to make themselves acquainted with the surgical technique necessary to ensure cleanliness.

*Choice of a catheter.* A rigid metal instrument, on account of the difficulties attending its passage, is unfortunately not available. The choice will therefore lie between a soft red rubber, and an olive-headed or Coudé black French instrument. It is unnecessary here to describe these instruments beyond insisting that the surface, both internal and external, should be smooth, and the part of the instrument beyond the eye, solid. The most convenient sizes are Nos. 8, 9, and 10, English scale.

A soft red rubber instrument has the following advantages :—

1. The impossibility of injuring the urethra by its introduction.
2. Its capability of withstanding, uninjured, repeated boilings.
3. Its ability to pass round sharp angles in the urethra when a stiffer instrument would be arrested.
4. The fact that it can be curled up and easily carried about.

It has the following disadvantages :—

1. It is not rigid enough to overcome any but the slightest obstruction to its introduction.
2. Owing to its pliability the part to be introduced must be grasped with the fingers.
3. The small calibre compared with its external diameter.

The olive-headed French black catheter has the following advantages :—

1. Its ease of introduction except in a sharply distorted urethra.
2. Its stiffness is sufficient to allow its introduction without fingering of the part to be introduced.
3. Its ability to overcome slight resistance.

It has the following disadvantages :—

1. Its inability to withstand repeated boilings.
2. The roughening of the surface which results from immersion in antiseptic solutions.
3. The possibility of its small point hitching in some inequality in the canal.

The Coudé catheter has the same disadvantages as the last instrument, but it has the advantage of being able to pass through a urethra which is much distorted in the antero-posterior direction (see Fig. 30).

*Introduction of the catheter.* Patients usually choose their own position. Some prefer the erect, some the supine, and some a sitting posture with the perineum unsupported. The catheter having been sterilized, and the necessary bowls, lubricant, and towels provided so as to be within reach, the patient must arrange his clothes so that there is no possibility of these coming into contact with his hands, penis, or instrument. The hands and the end of the penis having been washed in soap and water and wiped with a clean towel, the instrument is taken out of the sterilizer by the right hand grasping its end, dipped into a lubricant, and introduced into the external meatus, the left hand steadying the penis. It is then slowly and carefully pushed home. If the soft red instrument is used, the right hand must grasp the catheter close to the point and gradually pay the instrument into the external meatus; this process is rendered more or less difficult by the slippery nature of the lubricant. If a Coudé catheter is used, it is necessary to take care to instruct the patient to pass it in such a manner that the beak points upwards.

*Sterilization of the catheter.* The red rubber or metal catheters can be boiled every time they are required. After use they should be washed, reboiled, and put away dry. The black French catheters will not stand this frequent boiling. They can be sterilized by boiling when first taken into use. After they have been passed they must be thoroughly washed, then immersed in a long specimen jar filled with perchloride of mercury. From this receptacle they may be withdrawn, lubricated, and at once introduced into the urethra. They must be discarded directly the surface has become rough or cracked.

*Lubrication of the catheter.* This often presents some difficulties. The usual lubricants cannot be sterilized by the admixture of chemicals. Perchloride of mercury is probably inert when in solution in glycerine, since no dissociation of the salt takes place. Glycerine, oil, or petroleum derivatives can be sterilized by heating them in flasks, and in hospital practice present no difficulty.

The paraffins have the disadvantage that they cannot be saponified by washing with soap. The material is therefore likely to remain on the instrument and hinder future sterilization.

It is therefore probable that glycerine or an oil that can be sterilized by heat, and saponified by means of an alkali, is the best lubricant for catheters.

*Carriage of catheters on the person.* When catheters have to be carried about the patient's person for use during the day a good deal of difficulty must arise. This has been minimized by an ingenious apparatus devised by Herring, in which the catheters contained in metal tubes are sterilized by immersing the catheter and the tube in boiling water, on the surface of which floats some liquid paraffin. The tubes and their contained catheters are withdrawn after sterilization, the catheter in the process of withdrawal becoming covered with a coating of the lubricant. The ends of the metal tube are then sealed with rubber corks which have themselves been boiled. When dry on the outside such tubes can be stored or carried about the person. This method seems a most excellent way of getting over the difficulty of lubrication of a catheter under all circumstances.

*Difficulties and dangers of catheterization.* The dangers of self-catheterization depend on the risk of infecting the bladder. The likelihood of infection depends a good deal on the social condition of the patient, and on the facilities available for sterilization of the instrument. An educated patient and one of means can perhaps be taught the necessary technique, and carry it out at leisure in his own house, provided he can arrange to be at home when the catheter is required. Should this patient be compelled to travel, it is very uncertain whether the necessary details can be carried out. One has only to picture the passage of a catheter in a railway lavatory to appreciate the difficulties, even if a sterilized catheter, as proposed by Herring, is carried about the person.

In the case of the wage-earning classes, the difficulties are practically insurmountable, even if the individual can be impressed with the importance of attention to details of cleanliness. The trouble required to provide a stock of sterile instruments is by no means slight, and one can hardly imagine a working man carrying out the details in a cottage, though a patient of higher social standing might, with considerable determination, master the necessary technique.

If cystitis is to be avoided, the introduction of the catheter must be accompanied with the same precautions that are considered necessary in a hospital. A sterile catheter and sterile lubricant must be provided. The glans penis, and the patient's hands must be clean, and this last precaution is especially necessary if a soft instrument is used. To ensure sterility the catheter must be carried in some receptacle which is itself capable of sterilization. If a stiff instrument, and this is the best, is carried, its length is a decided objection. If a soft one is carried it can, it is true, be doubled up, but no very satisfactory receptacle has been devised for its reception.

It may be stated that infection of the bladder will occur sooner or later, no matter what class of patient has to be treated. It is certainly the exception to find cases of prostatic disease treated by prolonged catheterization which have not suffered or do not suffer from an alkaline cystitis.

It is perfectly true that patients may acquire a certain immunity from septic trouble, but no one would at the present day count upon a patient acquiring such an immunity. There is no getting away from the fact that sepsis is the cause of death in many cases of prostatic enlargement, and, even apart from this, the condition of a patient with cystitis is often truly horrible.

The fact must be faced, that a patient practising self-catheterization is almost sure to fall a victim to septic infection of the urinary tract.

### TREATMENT OF INFECTION OF THE URINARY SYSTEM

The occurrence of cystitis must be looked upon as a failure of treatment, and the possibility of its supervention as a powerful argument against catheter treatment. It is to be hoped that in the future the necessity for its employment will be greatly reduced.

If the catheter is used a careful watch must be kept on the state of the urine. Any sign of alkalinity must be remedied by the administration of the urinary antiseptics, such as urotropine or benzoate of ammonia, which may be usefully combined with hyoscyamus and buchu. The amount of fluid taken by the mouth can also, with advantage, be increased.

If these measures prove insufficient, and the urine remain foul, lavage of the bladder with normal saline fluid or a mild antiseptic should be practised. If these measures prove ineffective, and especially if the kidneys show signs of infection, the bladder must be opened and drainage instituted. It is of the utmost importance that the kidneys be saved from infection, if prostatectomy is to be successful.

Infection of the bladder by the bacillus coli communis is not uncommon, and occurs with the urine still acid. The symptoms are often not pronounced, and the infection may be unsuspected until a cultivation is made from the urine. Fortunately, the virulence of the organism is not high, and does not, in the great number of cases, seriously prejudice the chances of a successful prostatectomy. On the other hand, it may cause grave results, especially if the urine undergoes ammoniacal decomposition.

No drugs seem to have the least effect in ridding the urinary tract of this bacillus. If the infection is grave, and constitutional signs are present, the injection of a multivalent coli serum, followed by vaccine treatment, is indicated, and the results of such treatment in the past have been such as to give good hope for the future.

### TREATMENT OF RETENTION

When the introduction of a catheter is possible, the treatment of chronic retention, which has become established late in the disease and is an extreme form of residual urine, resolves itself into the question of the advisability of prostatectomy or a continuance of catheterization.

Acute retention may in some degree be prevented by avoiding chills, constipation, dietary indiscretions, and the necessity of resisting the desire for micturition. It will occur, however, in spite of all precautions, and when present the treatment offers some points for discussion.

In the first place an attack of acute retention is not unusually a first symptom of the disease, or it may occur early in the disease. Such an attack may be got over by a hot bath, a morphia suppository, a sharp purge, or the use of the catheter, and rest in bed. When the retention has been relieved, the patient may return to the normal or to the condition in which he was before the attack. The advice as to the future will depend on the length of the symptoms, the local condition of the parts, and the medical attendant's views on the operation of prostatectomy.

If no instrument can reach the bladder, and the symptoms are urgent, immediate relief is necessary. The alternatives are supra-pubic aspiration or supra-pubic cystotomy. The choice will depend on the feasibility of a subsequent radical operation, and the patient's willingness to submit to it. If the case is of long standing, the prostate large and elastic, and the idea of obtaining permanent relief pleasing to the patient, a supra-pubic cystotomy is the best course. On the other hand, if the prostate is hard and small, and the patient adverse to the risk of a radical cure, aspiration offers a means of temporary relief, in the hope that, by rest, spontaneous micturition will be re-established, or that the catheter will be able to enter the bladder. The inability of a catheter to enter the bladder when retention is present, and its ability to do so when relief has been given, is most probably due to an increase in the distortion of the urethra brought about by the pressure of the retained urine on the prostate.

If the urine is foul, aspiration is perhaps best avoided. It is not advisable to proceed to radical measures immediately after the relief of an acute retention, or when the bladder is foul from an alkaline cystitis. A period of drainage should always intervene.

## TREATMENT OF HAEMORRHAGE

Slight spontaneous bleeding is not a very serious symptom, and needs no active treatment. Severe or repeated haemorrhages are now taken as indications for radical measures; the same may be said of haemorrhages of any magnitude following the introduction of a catheter. Distention of the bladder with blood is best treated by a supra-pubic cystotomy, followed by prostatectomy at a convenient interval.

## TREATMENT OF CALCULUS

Stones are often met with in the course of a prostatectomy. If diagnosed as present in a case of enlargement of the prostate they should be removed by a supra-pubic operation, and prostate submitted to operation at the same time, or at a later date if thought advisable.

# CHAPTER IX

## OPERATIVE TREATMENT

### CHOICE OF TIME FOR OPERATIVE INTERFERENCE

WHEN the time of catheter life has arrived, the surgeon and the patient are both brought face to face with the alternatives of catheterization or operation.

Putting aside carcinoma, we have seen two forms of enlargement may be met with, viz. :—the encapsuled form and the non-encapsuled form. Sufficient observation has not yet been made as to the results of operation in the non-encapsuled form, but fortunately this variety apparently forms a small proportion of all the cases which present symptoms. About the success of operative procedures on the encapsuled form there can be no doubt. Enquiry will have to be made as to whether the fibrous form will be met with more frequently if the operation be undertaken at an earlier date than at present. Should it prove that the encapsuled form is met with as frequently at an early period as it is after the disease has progressed for some time, there can be no doubt that early operation will eventually become an established practice. The position of the surgeon will be made much easier if the future is able to provide a certain means of diagnosis between the encapsuled and non-encapsuled form. At present, the power to make this differential diagnosis is wanting, and there is no certain means of telling, even if the symptoms have been in duration for some time, whether the growth will shell out or require piece-meal removal. A long duration of symptoms and a large, smooth and elastic tumour are in favour of an encapsuled growth. On the other hand, small enlargements of the organ are also often of the encapsuled form, and shell out easily.

It is probable that for some time there will be considerable difference of opinion as to the desirability of early operation, when the introduction of a catheter once in the twenty-four hours relieves a patient of all discomfort. When the period has arrived at which the patient is totally dependent upon the catheter for the passage of his urine, the advisability of operation becomes considerably enhanced. The catheter will now certainly have to be passed sometime in the middle of the day, and the difficulties of cleanly catheterization will be augmented, while the fact that the disease has been in progress for a considerable period has increased the probability of encapsulation. When the passage of a catheter is impossible, or when its introduction is accompanied by haemorrhage or great pain, or when the patient suffers from spontaneous haematuria, there is no choice, and operative procedures can alone relieve the patient.

Obstruction to the outflow of urine cannot exist for any length of time without producing not only grave effects on the bladder, but also on the kidneys. In addition, there is the risk of renal infection to be reckoned with.

If prostatectomy is to be uniformly successful, it must be practised on patients with sound kidneys and urinary apparatus.

To recapitulate:—When the introduction of a catheter is impossible, or recurrent haemorrhage occurs, there is no doubt as to the advisability of operation. When, although a catheter can be passed, retention is complete, operation is certainly advisable. When the patient is just entering on catheter life, and the prostate is large, soft, and elastic, operative interference should, I think, offer the best means of relief. When the contrary conditions pertain the indications are not so clear, but it is to be hoped that, with time and greater experience, early operation may be found practicable in all cases.

### CHOICE OF OPERATION

When operative treatment has been decided upon, there remains the nature of the operation to be determined. The following are the operations which have been advocated or adopted :—

1. Vasectomy.
2. Castration.
3. Operation on the pelvic floor.
4. Operations directly on the prostate itself—
    - (*a*) Enucleation.
    - (*b*) Piece-meal excision.
    - (*c*) Scarring operations by an electric cautery.

It was shown in Chapter II that the division of the vasa deferentia had no effect either on the testicle or on the prostate. It was also pointed out that castration produced an atrophy of the normal prostate, but it could not be relied upon to bring about a diminution in the size of a pathologically enlarged organ (*Pathological Society's Transactions*, vol. 56). No hope of relief can, therefore, be found in either of these operations.

Incision of the pelvic floor has been advocated and, I believe, even practised. This procedure is based on the assumption that the obstruction to the outflow of the urine is produced by the displacement upwards of the enlarged prostate brought about by its enlargement. It is held that by dividing the pelvic floor the prostate is allowed to resume its normal position, so that the lowest portion of the bladder regains its usual level, and normal micturition is thereby re-established. A study of the morbid anatomy shows that this idea is altogether erroneous, and that no amount of dropping of the prostate can counteract the interference of the prostate with the sphincter vesicae, the increased urethral pressure, and the distortion and elongation of the urethra. It is unlikely, therefore, that this operation will find any acceptance.

*Operations on the prostate itself.* There is no doubt that direct interference with the gland is the operation of the future. Fortunately the greater number of enlargements lend themselves to the enucleation method. This should therefore be tried in the first instance.

If no line of cleavage can be found, the choice must lie between a piece-meal removal or an operation of the Bottini type. The idea of the latter operation is, to produce, by means of an electric cautery, a series of scars in the lateral and posterior portions of the prostate, and, by their contraction, a shrinkage in the bulk of the organ. If the Bottini instrument is used, as it was originally, with an unopened bladder there must be considerable danger attached to the procedure, since there is no means of telling to what extent the burning has been carried. If a supra-pubic opening has been made into the bladder the instrument can be controlled by sight, and a grave objection to this procedure removed. It has been claimed by surgeons who have practised this operation that the results are good, and I have myself seen a patient who, by its aid, pronounced himself as completely cured. Beyond this, I have no experience of the operation.

The remaining method is that of piece-meal excision. It is certainly not an ideal operation, but there may be no choice between its practice and leaving the patient without any attempt being made for his relief. Its performance, either by the perineal or supra-pubic routes, demands a good deal of care and judgement. If pushed too far, there is danger of the pelvic fascia being opened and of septic trouble ensuing. In two cases which I have seen, micturition by the normal passages was never re-established, and the patients were, if anything, in a worse plight than before operation. On the other hand, many patients have been materially benefited. A good deal of experience is needed as to the part to be attacked and as to the amount to be removed, before this operation can be placed on a really sound footing. The prostates which have to be so attacked are usually, but not always, small. They are generally hard, and show but little intra-vesical projection. There cannot, therefore, under such conditions, be much gland to be removed, and those who are wise will confine themselves to a limited removal.

### CHOICE OF ROUTE

The best route by which to perform prostatectomy is still keenly debated. In England the supra-pubic method is, and has been, the more popular. Abroad the perineal route has been the more largely used; there are signs, however, that the high operation is gaining in favour. As regards accessibility of the prostate during removal of the tumours there is but little to choose. In the supra-pubic method, the inferior part of the organ may be hard or almost impossible to reach, while the same is true of the vesical portion of the prostate when the perineal route is adopted. Tumours of the 'middle lobe' are said to be more easily reached through the bladder than through the perineum. Experience shows that the commonest form of enlargement is that in which an adenoma is developed in each lateral mass of the organ. If a tumour is found which projects behind the urethra, it is almost in every instance an extension from one of the lateral tumours, or arises from the bridge of adenomatous tissue which joins them (horse-shoe-shaped tumour).

When the bladder is opened from above and a finger introduced into the rectum, the organ lies between the two hands of the operator with very little tissue interposed, and a very accurate idea of its size, consistence, and shape can be obtained. The upper hand is in actual contact with the organ, while the lower is only separated from it by the thickness of the rectal wall. When the perineal route is used, the lower hand only is in actual contact with the prostate, while the upper hand is separated by the thickness of the belly wall. This disadvantage has been obviated by making an incision through the abdominal parietes, or even by opening the bladder (combined method). By adopting the perineal route and by the use of tractors the prostate can be brought down into the perineal wound, the capsule incised, and the growth enucleated under the eye. When the operation is performed from the bladder, the removal is done by the sense of touch. This is not such a grave disadvantage in the encapsuled tumour as might appear, for under these conditions the finger quickly enters the line of cleavage and follows that line until enucleation is complete, and there is practically no need to make any attempt to guide the enucleating finger, since it readily follows the line of least resistance. When one of the non-encapsuled forms of enlargement is encountered, the perineal method, since it allows removal to be performed by the sense of sight, would seem to be the more preferable. Theoretically, the perineal route affords the best drainage, but in practice it is found that the supra-pubic route offers no real disadvantage in this respect. A syphon tube is enough, as a rule, to carry away the urine as it is secreted, and if a difficulty is found in keeping the patient dry, a Sprengel's water pump or Colt's tube will do all that is required. If thought advisable, a simple median perineal section, after the supra-pubic prostatectomy, will give inferior drainage.

It has been held that, by adopting the combined method, or the perineal with the use of tractors, and by enucleating the tumours one by one, the urethra and bladder mucous membranes can be left intact, and by their integrity prevent the soiling by the urine of the couch from which the tumours have been removed. The writer's own observations would lead him to believe that it is only in a very few instances that the mucous membrane of bladder or urethra can be left unbroken. The tumours often project far into the bladder, and the mucous membrane over them is usually so attenuated as to be incapable of being raised from the underlying tumours without rupture (see p. 10). It is certainly remarkable how seldom unpleasant symptoms due to infection by foul urine follow prostatectomy. The dangers can be still further reduced if a preliminary cystotomy, followed by a period of bladder drainage, is employed before the prostatectomy is performed.

Hugh Young states that, by the use of the perineal method and of incisions on either side of the mid-line, the adenomata can be removed one by one, and the posterior median portion of the prostate containing the ejaculatory ducts left intact (see page 159).

Provided that the operation has been satisfactorily performed, there is apparently no difference in the time taken for the bladder to close, no matter what route has been adopted, nor is one method more likely to cause stricture than the other.

As has just been stated, the perineal route would apparently be the most favourable for attacking fibrous prostates, and should therefore be adopted if such diagnosis can be made with certainty. Unfortunately it appears that it is impossible, before the actual attempt is made, to say which prostates contain enucleable tumours and which do not. It is certainly the case that prostates enlarged but little above the normal, and even of hard consistence and therefore presumably of the fibrous and non-enucleable variety, prove eventually to be adenomatous and to contain enucleable tumours. The mortality of the two routes is nearly equal. Lynn Thomas gives it as 0·9 in favour of the perineal.[1]

It would therefore appear that ease of removal when once the prostate has been reached, the facilities for drainage, the rapidity of closure of the wound, and the mortality are about equal with the two methods. In the case of the supra-pubic route, a simple cystotomy and the introduction of a finger to the rectum brings the organ at once within reach. In the perineal route, on the other hand, a more or less lengthy dissection has to be performed before the prostate can be reached, and there is a certain danger that in this process of dissection the rectum may be wounded. In addition to this, the lithotomy position is not so favourable to the patient as is the supine. The ease with which an anaesthetic is taken is of great moment, considering the age of such patients and their liability to lung complications.

There can be no doubt that by far the larger number of tumours of the prostate, probably something like 75 per cent., can be quickly, easily, and efficiently removed by the supra-pubic route. Considering the difficulty in accurately diagnosing the non-enucleable form, it is open to question whether it is worth while considering the advisability of adopting the perineal method as a general rule.

The question of the perineal route is further discussed in the chapter on Carcinoma.

[1] See footnote on page 160

# CHAPTER X

## PROSTATECTOMY

*Preliminary considerations.* It is to be again insisted that no radical operation should be undertaken when acute retention is present, or when the patient is worn out by sepsis and want of sleep. In these cases a preliminary cystotomy is the right treatment. Even when such complications are not present, but the urine is alkaline, an attempt should be made to get the bladder in good condition before proceeding to a radical operation. In an aged patient even a recent bladder infection may be an indication for bladder drainage, with a view to avoiding further septic infection, and as a preliminary to prostatectomy.

### SUPRA-PUBIC PROSTATECTOMY

This is the operation which has been advocated by Freyer, and to this operator belongs the credit for the revival of prostatectomy in England. There can be no doubt that the publication of Freyer's results marked an immense forward stride in the treatment of enlarged prostate.

*The operation.* The hand which provides the finger to be introduced into the rectum should be clothed with a rubber glove. This is to be recommended on two grounds, firstly, because after enucleation this hand may be required to complete the operation, and secondly, because it may be necessary to change hands in the course of operation. Lynn Thomas has devised an instrument which can be inserted into the rectum and take the place of the finger, thus avoiding any soiling of the hand. The delicacy of touch ensured by the bimanual method is lost by the use of this instrument, and it is doubtful, therefore, whether its advantages compensate for its disadvantages.

The Trendelenburg position in certain cases renders the prostate more accessible. Although this position is not an ideal one from a general point of view, it is advisable to have the patient on a table in which this position can be arranged with as little disturbance to the patient as possible.

If possible, the bladder is first washed out, and then filled with normal saline. If a catheter will not enter, the bladder must be opened without the aid afforded by its distension. A vertical incision is made through the mid-line, the recti separated from one another, and the bladder exposed. Two thick catgut sutures are then passed through the bladder-wall, and the viscus opened between them. These supporting sutures are not really necessary, but are to be recommended, since traction on them during the process of enucleation prevents the tearing away of the bladder from its surroundings, and a consequent formation of a large space outside the viscus in which urine can lie. Directly the bladder is incised, and before any of the fluid has had time to escape, a finger is introduced, and the condition of the prostate and the amount of its intra-vesical projection, and the condition of the internal meatus determined. A finger or two fingers are now introduced into the rectum, and the organ examined bimanually.

It is now possible to tell if enucleation is likely to prove easy. If the prostate presents a well-marked intra-vesical projection, and is large, smooth, and resilient, it is fairly certain to offer no great difficulty. If the organ is small, hard, and presents but little intra-vesical projection, the operation may be accompanied by great difficulty, even if it prove possible. Nevertheless it often happens that the small prostate will lend itself to enucleation, and the only way of proving or disproving the possibility of enucleation is the attempt to do it.

*Enucleation of the tumours.* The shelling out is commenced by cutting or scratching through the mucous membrane near the summit, and on the vesical side of the intra-vesical projection. The mucous membrane, which alone covers this part of the gland if the intra-vesical projection is large, is quickly penetrated, and the finger, passing downwards, soon penetrates within the internal sphincter and enters the line of cleavage. This line may be either on the surface of the adenomatous mass itself or lie between the planes of the 'capsule'. Continuing the separation, the finger now sweeps round to the opposite side of the prostate, tearing as it goes the bladder mucous membrane from that lining the urethra, so that when the finger has completed the circuit of the intra-vesical projection, a ditch, so to speak, will have been dug round the upper or vesical portion of the prostate.

The enucleation is concluded by a deepening on all sides of this cleft until the lower part of the prostate is reached, and the finger again comes in contact with the urethra at the apex of the gland. The urethra is then either torn or cut across, and the tumour, which now lies free in the bladder, is removed through the supra-pubic opening. Even when encapsulation is well marked there are two points where some difficulty may be encountered. The first is at the commencement of the operation, in finding the line of cleavage. It is met with in those cases of prostatic enlargement in which there is very little intra-vesical projection, and in which for this reason a layer of bladder muscle still lies over the prostatic adenoma. Such a condition as this is seen in Fig. 28. The second difficulty met with, is at the lowest part of the prostate where, owing to the depth of the wound, the enucleating finger becomes almost powerless, and a change of hands may even be necessary. The finger or fingers in the rectum, which have been used to push up and steady the prostate during the previous portion of the enucleation process, are often unable at this point to raise the prostate or be of much assistance.

In those cases in which the encapsulation is deficient, the operation may be one of considerable difficulty. Instead of quickly finding the line of cleavage and rapidly completing the enucleation, the finger at first makes little or no progress, and then finds a cleavage line, only to be brought up by tough areas through which it is exceedingly difficult to find a way, and which may require the scissors for their division. In such a case the only remedy is patience, and to pay careful attention to the guiding finger in the rectum, which will quickly show the enucleating finger if it is in danger of transgressing the limits of the prostate.

Tumours removed under such conditions, although they conform to the type removed by easy enucleation, are apt to be irregular in shape and to show a rough and ragged surface even when the surfaces of the adenomatous masses are exposed, while the 'capsule' when present is formed of very irregular bands; in fact the external appearance of such tumours contrasts somewhat sharply with the smooth lobulated surface and circumferential capsule fibres of those tumours removed when the operation proves easy.

It is not possible to predict what type of tumour (see p. 179) will be removed by enucleation, and the operator has very little power in determining this; the finger enters the line of cleavage and completes the operation in this line. It may be that the cleavage line lies on the surface of the adenoma, and if so, the tumour removed may be an adenoma in one lateral mass, and the process will have to be repeated on the opposite side. At another time the finger penetrates to the surface of the tumour and removes one of the horse-shoe type. Again the line of cleavage will run through the 'capsule', in which case tumours, of various forms and containing the urethra, will be removed surrounded by a 'capsule'.

*Prostatectomy by piece-meal excision.* If after patient trial the enucleation operation proves impossible, three courses remain open. Either the operation must be abandoned, the growth removed piece-meal with scissors and punch forceps, or scarring produced by the application of an electric cautery. Of the last operation little can be said, except that when the bladder has been opened and a speculum introduced, the cautery can be applied with comparative safety. If it is decided to remove the growth piece-meal with scissors or punch forceps, care must be taken that the confines of the gland are not passed, and irreparable damage done. Probably the best results are to be obtained by removal of the growth which lies behind the urethra, as by this means the valvular nature of the internal meatus and upper urethra is destroyed.

*Treatment after supra-pubic prostatectomy.* After the operation is finished, the bladder should be irrigated with saline fluid at about a temperature of 115° F. This is usually sufficient to check any haemorrhage if it occur. It is best performed by means of a catheter introduced through the penis, the eye of which lies in the cavity left by the removal of the prostate; the fluid escapes through the supra-pubic wound. The author prefers to anchor the sides of the bladder wound to the deep layers of the rectus sheath, the incision in the bladder being reduced by catgut sutures so as to admit a large sized catheter. The anchoring of the bladder is unnecessary, but it has the advantage of facilitating the reintroduction of the catheter, should this by any means slip out of the bladder. The anterior rectus sheath is brought together

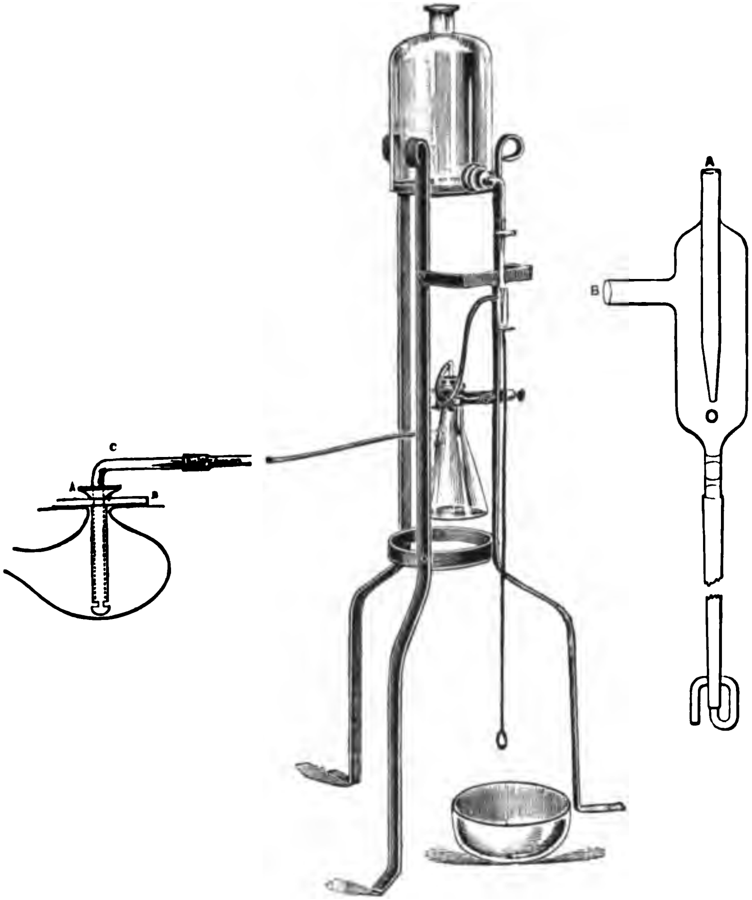

FIG. 48. The flask, seen in the middle of the centre figure, is connected on one side with the bladder, and on the other with the water-pump by means of which a vacuum is maintained. The flask should be on the same level as the patient's body. The left-hand figure shows a silver tube provided with lateral openings at the bottom and a collar by which it rests on the abdominal wall. Into it dips a bent glass tube connected with the vacuum flask. The right-hand figure is the water-pump itself. The passage of the water through the latter is regulated by a screw clip. The water should run slowly, so that each drop is followed by an appreciable interval.

with a few catgut sutures, but a space is left beside the catheter to give free exit to any urine which may escape around the instrument. The top and bottom of the skin wound is then closed. Some operators use no sutures to the bladder, but allow it to drop back, and insert a large drainage tube, the urine being allowed to escape into the dressings. I have tried both methods, but do not find that the latter leads to any material shortening of the period of supra-pubic leaking. It is doubtful, therefore, if the discomfort of continual soakage in urine is at all compensated for.

The operation completed, the patient is put back to bed, and any shock treated in the usual manner. If a catheter has been inserted into the bladder, this is connected with a syphon tube or a Sprengel's pump (see Fig. 48). This pump, the details of which were devised by Mr. Edmund White, has been in use for many years at St. Thomas's Hospital. It is very simple to work, seldom gets out of order, and by its means the patient can nearly always be kept dry and comfortable.

The urine may remain blood-stained for somewhere about a week or ten days. The passage of clots occasionally, though seldom, gives trouble, and blocks the catheter if this method of drainage is used. It is, however, a simple matter to clear the catheter by injecting a little normal saline through it. Occasionally the post-operative haemorrhage may give more trouble, and fill the bladder with clots, when it will be necessary to reopen the wound and empty the bladder. Such haemorrhage may occur within a day or two of the prostatectomy, or at the end of the first week, when it may be properly considered as secondary haemorrhage. Fortunately in neither case is the haemorrhage very persistent. Clearing out the bladder, and irrigation with hot saline is usually sufficient to control it. It is conceivable, however, that more vigorous means might have to be taken to deal with it, when packing the prostatic couch with gauze would probably be the most efficient way of meeting this emergency. If the haemorrhage has occurred at the end of the first week, and is therefore of the nature of a secondary haemorrhage, it would be desirable to enlarge the supra-pubic opening, which would have by this time become somewhat contracted, and thus afford more efficient drainage. It is not unusual, when spontaneous micturition begins to be established, for the urine to be tinged with blood, or even for clots to be passed. This need give rise to no anxiety, for it passes away without the necessity for any special treatment.

Habitual irrigation of the bladder is not necessary, and urotropin or some other urinary antiseptic will, as a rule, keep the urine sweet and the patient free from smell. At the end of five or six days the catheter is changed for a smaller one, and at the end of ten or twelve days a still smaller sized one is substituted, or the catheter altogether discontinued. The date of the final removal of the catheter should be decided by the condition of the supra-pubic wound. If this is sound, healthy, and contracting well, the tube may be left out; but if, on the other hand, the wound is dirty, it is better to continue the drainage, as such a wound will not close until it is clean and free from slough. Directly the tube is dispensed with, or even before, if it is necessary to keep the tube in for a lengthy period, the patient can have a daily bath, and gradually get on to his feet. Micturition by the normal passages is usually established somewhere about the third week, but the period of its re-establishment is very various, and it is not unusual for the sinus, when apparently closed, to occasionally open and discharge urine, especially at the time of micturition. There is, as a rule, no need for the introduction of any instrument into the urethra with a view to avoiding a stricture, though the passage of a steel sound before the patient passes from observation is advisable, to ascertain the condition of the urethra at the junction of the prostatic and membraneous portion.

Spasm of the muscles of the perineum is occasionally troublesome for a day or two after operation. As far as can be ascertained, this has no connexion with the presence of a tube in the bladder, or with a distension of the bladder by fluid. It is difficult to treat, but happily passes off as a rule in the course of a few days. No drugs have any very direct effect, but potassium bromide by the mouth and a morphia suppository by the rectum are usually sufficient to make the patient fairly comfortable.

### PERINEAL PROSTATECTOMY

The object of this operation is to attack the prostate from its apex or from its rectal surface. The patient is placed in the lithotomy position, and a staff introduced into the bladder through the penis. A straight vertical, a V-shaped, or crescentic incision is made into the perineum, and the dissection carried down to the fibro-muscular band which passes from the urethra to the rectal angle. This is divided, and the membranous urethra and the apex of the prostate exposed. The procedures now differ somewhat in detail.

1. The membranous urethra is incised at the apex of the prostate, and the finger introduced into the prostatic urethra. Enucleation is then carried out, commencing either at the superior or inferior extremity of the prostate. In order to steady and render the organ more accessible, pressure is made with the hand on the hypo-gastric region. If this is deemed insufficient, an incision can be made through the abdominal wall, and pressure applied through the bladder wall, or the bladder itself opened and direct pressure made on the prostate. This operation is

essentially the same as the supra-pubic enucleation, the prostate being attacked from the perineum instead of from the bladder. Enucleation is performed by the sense of touch, and no particular care is taken to avoid the ejaculatory ducts. The bladder is drained through the perineum or penis. The operation is only suitable for dealing with an adenomatous enlargement, and presents no advantages over the supra-pubic method just described.

2. The apex and the lower part of the posterior surface of the prostate are exposed by the division of the anterior fibres of the levator ani, and by retraction of the more lateral ones. The prostate is then depressed into the wound by pressure on the staff within the urethra, or the membranous portion of the canal is incised, a prostatic retractor inserted into the bladder, expanded, and the prostate pulled down into the wound. Two incisions, one on either side of the mid-line, are then made into the 'capsule', and the adenomata enucleated from the lateral portions of the organ, or a portion of the prostate is removed by 'morcellement', should the enlargement prove of the tough variety. No care is taken to avoid the ejaculatory ducts, and the bladder is drained by the perineal route.

3. The posterior surface of the prostate is fully exposed by the insertion of the fingers into the areolar space between the rectum and the prostate (space of Denonvilliers). A vertical incision is now made through the posterior surface of the 'capsule'. By means of a supra-pubic cystotomy the prostate is pushed down, and the finger or blunt instrument in the perineal wound sheds the 'capsule' off the prostate. The finger in the bladder directs the enucleation when the stripping process has reached up to where the prostate lies beneath the mucous membrane of the bladder or urethra. It is claimed that the enlargement can thus be removed without opening the urethra

or bladder. The cavity left by removal of the prostate is packed with gauze, and the bladder drained through the urethra or supra-pubic opening.

4. The posterior surface of the prostate is exposed as in the last case, the urethra opened, and a tractor inserted into the bladder. Two vertical incisions are then made, one on either side of the mid-line. Each lateral lobe is freed and removed. It is claimed that the ejaculatory ducts are saved, as they lie in the intermediate portion of the prostate between the two vertical incisions. Perineal drainage is employed.

5. The posterior surface of the prostate is exposed. A tractor inserted into the bladder through an incision in the membranous urethra. An incision is then made through the 'capsule', and each lateral lobe separated on its inferior, lateral, and vesical surfaces. The prostatic urethra is then slit up. A finger is introduced into the urethra, and the lateral lobes separated by careful dissection from the canal. The ejaculatory ducts are ligated, the urethral wound is then closed round a perineal tube, and a catheter is also introduced into the bladder through the penis.

It will be seen that the operations described fall into two main categories. The first performs enucleation by the sense of touch, as is done in supra-pubic operation. The second attempts to use both the hand and the eye. It would therefore be an ideal process when the prostate has to be removed by 'morcellement'. It is very doubtful if the refinements, such as leaving the bladder, urethra, and vasa deferentia intact, can really be carried out in the majority of cases.

The descriptions of the perineal operation are rendered difficult to follow because of the confusion still existing as to the use and the meaning of the terms 'capsule' and 'sheath'. Some operators recognize that the 'capsule' is an altered portion of the gland proper, and talk of the operation as being conducted within the confines of the gland. Others describe a 'capsule' which the author believes to be an altered portion of the gland, but talk as if the removal were carried out through the fibrous sheath of the organ.

The truth of the matter is, that when the prostate is attacked from the perineum, the expanded outer portion of the prostate has to be incised, and the adenomata removed from within their newly formed capsule. In the case of the non-encapsuled varieties the 'capsule' is deficient or non-existent, and the organ is simply bitten away piece-meal.

## THE RESULTS OF PROSTATECTOMY

In determining the claim of prostatectomy to be considered a success, several points have to be settled, namely:—the degree to which the natural functions are restored, the percentage of cases in which good function is regained, and the mortality connected with the operation.

It is intended to speak only of the results attained by the enucleation operation.

*Closure of sinus.* The supra-pubic sinus is closed and normal micturition established in about one month. Sometimes this occurs as early as the fourteenth day, and is rarely delayed beyond five weeks. If the operation has been of the usual kind, and no special difficulties of enucleation encountered, there need be no anxiety as to the ultimate sound closure of the operation wound.

*Stricture.* Any narrowing of the urethra, even when the whole of the mucous lining of the prostatic urethra has been removed with the tumour, is of rare occurrence, the canal admitting the passage of a medium-sized steel sound without difficulty, save for a slight hitch at the neck of the bladder. In those instances in which some narrowing supervenes, it is most probably due to a rupture of the 'capsule', and a transgression of the limits of the gland near the apex of the organ, and is therefore most likely to be met with in the imperfectly encapsuled type of enlargement, which requires the employment of a considerable amount of force for its removal.[1]

*Recovery of the bladder.* It is usual for a certain amount of frequency of micturition to continue for some time after the closure of the bladder. In some cases this frequent micturition, especially at night, remains permanently, but it does not incommode the patient. In other cases, however, the intervals become longer and longer until the patient returns to his usual routine, and the nights are undisturbed. This post-operative frequency is unconnected with alkalinity of the urine, and is possibly due to the small size of the bladder brought about by pre-operative conditions, and by the period of bladder drainage.

The power of propulsion is rapidly regained. This fact, as pointed out by Freyer, is enough to show that hopeless deterioration of the muscle and atony of the bladder must be of very rare occurrence, even in those cases in which obstruction to the outflow of the urine and cystitis have been of long duration, and is sufficient in itself to refute the theory of a primary failure of the muscle coats.

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[1] The following case is interesting. J. T., male, aged 69, had suffered from prostatic symptoms for five years. Supra-pubic prostatectomy was performed and a tumour containing the urethra was removed. It was of the ordinary twin tumour type and weighed 30 grams. The patient was discharged, with the sinus closed, five weeks after the operation. Micturition was normal. No sound was passed. Fourteen days later the sinus opened and more and more urine was passed through it until normal micturition ceased. The bladder was again opened ten weeks after the first operation, and examination showed that the mucous membrane was continuous over the internal meatus. The cavity from which the tumour had been removed was only just recognizable.

A steel sound was passed and entered the bladder without difficulty when once the mucous membrane had been perforated. There was no real contraction of the urethra.

The patient was eventually discharged with normal micturition. This is the only case of trouble with the urethra that I have met with.

*The fate of the operation cavity.* Patients on whom prostatectomy has been performed declare that the sensations connected with the emptying of the bladder are identical with those of the normal state. It is therefore interesting to inquire what becomes of the cavity left by the removal of the adenomatous masses. That the cavity rapidly contracts is an observation that can be made at the time of operation, and, when an opportunity occurs owing to the death of the patient, a few days after the operation. As to its ultimate fate little is known. Thompson Walker has described a case which he examined two years after operation. In this instance, a cavity, though small (the size of a hazel nut), remained at the site of the prostatectomy. Walker considered that the internal sphincter in this case had remained dilated, and consequently hardly likely to perform its functions as a sphincter. It was therefore thought that the constrictor urethrae had probably acquired a greater importance than under normal conditions. The cavity communicated with the bladder by an aperture that admitted the tip of the little finger. The posterior boundary of this aperture was formed by a ledge, the upper surface of which corresponded to the trigone of the bladder. The membranous urethra at its point of junction with the cavity had the calibre of an ordinary lead pencil. There was no sign of cicatricial contraction.

The interior of the cavity was smooth. On section, its wall showed tough granular-looking tissue, which under the microscope revealed dense fibrous tissue and a large amount of striped muscle. The lateral and posterior walls were thinner than the anterior, and had only the thickness of brown paper. The interior was lined by a layer of cells of varying depth. Sometimes the cells formed a single layer, sometimes two layers, sometimes they were met with in heaps. The superficial ones were flattened, the deeper ones rounded in outline. Occasionally the lining cells were wanting altogether (see also footnote, page 157).

*State of sexual power.* The sexual potency of the individual after operation is not really of much moment. The state of the patients before operation is such that they are not inclined to be captious on this score.

The writer's own experience would show that the sexual desire and virility are not altered by the operation. The virility shown by the subjects of prostatectomy does not in the least degree indicate that the vasa deferentia are uninjured and patent, or that the individual can beget children. It was shown in the earlier part of this work that the nutrition of the testicles was independent of the integrity of the vasa, and that the power of sexual congress was not altered by section or ligation of the vasa deferentia.

The question of the escape of the ejaculatory ducts must therefore be settled on anatomical grounds. The answer to this inquiry is to be found in Fig. 59. It will be seen that, if the 'capsule' is replaced into the cavity from which it was removed, the posterior wall of the urethra is left intact, even after the removal of the two lateral adenomatous masses. The ejaculatory ducts opening on to this ridge, and running directly upwards and backwards would have escaped injury. If, on the other hand, the two lateral adenomatous masses had been removed in their 'capsule', the urethral ends of the ejaculatory ducts would have been removed in the process, and it is unlikely that they would have re-established their openings into the cavity left by the operation.

From these observations it may be generalized that when tumours are removed in a 'capsule' the ejaculatory ducts are sacrificed, but that the ducts may escape injury when isolated adenomata are enucleated.

*Mortality.* Lynn Thomas has collected the latest statistics (*Brit. Med. Journ.*, Nov. 1906). They include 677 perineal and 583 supra-pubic operations. The death-rate directly due to operation was 7·7 per cent. in the supra-pubic, and 6·8 per cent. in the perineal cases. The death-rate due to remote causes was 3·4 per cent. in both classes. The percentage of complete cures was 81·4 per cent. in the perineal, and 95·6 in the supra-pubic.[1]

The figures are taken from the published results of American, Continental, and British surgeons. It is probable that the results are a good deal more favourable than would have been the case if the figures had been compiled from hospital statistics.

*Conclusion.* There can be no doubt as to the success of prostatectomy in the adenomatous form of the enlargement, provided that the operation is performed on patients with reasonably sound constitutions. On the other hand, disaster can only be expected if the operation is performed on individuals worn out by pain and sepsis.

More experience is needed in the non-encapsuled form of the enlargement, both as to the best operative procedure, and as to the results of piece-meal removal.

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[1] Freyer (*Brit. Med. Journal*, March 9, 1907) has published 119 cases of prostatectomy with nine deaths, a mortality of 7½ per cent.

Hugh Young (*Johns Hopkins Hospital Reports*, Jan. 1907) gives 185 consecutive cases of perineal prostatectomy with a mortality of 3.7 per cent. He states that in the last two and a half years there have been 100 cases with a mortality of 2 per cent. In the last sixty cases there was no death.

# CHAPTER XI

## NATURE OF THE ENUCLEATION OPERATION

When the prostate is hard and fibrous and can only be removed by a process of tearing or punching, there is no doubt as to the nature of the operation; but when enucleation proves easy, and definite tumours are removed, there are still two opinions held. It is not disputed that isolated adenomata can be shelled out of the prostate. The difference of opinion arises when the tumours, often but not necessarily of large size, containing the urethra are removed. The question to be decided is whether such operation is of the nature of a real, total prostatectomy. The two views may be expressed as follows:—

Those who maintain that total prostatectomy is possible, admit that the normal prostate cannot be removed from the body by a process of enucleation, because of its intimate attachment to the bladder. They point out that the recto-vesical fascia can be freed from the prostate by blunt dissection over all the surface of the organ, except at the anterior commissure and the junction of the prostate with the bladder, and that the prostatic plexus of veins lying between the layers of this recto-vesical fascia can, therefore, be raised without damage along with this fascia. The ability to separate the prostate and the bladder in prostatectomy is explained by supposing that the prostate in the process of enlargement 'shakes itself loose' from its bladder attachments, and, in addition, loosens its attachment to the recto-vesical fascia. The enucleating finger in this operation of 'total prostatectomy' is said to sweep round between the prostate and its fibrous covering, separating them from one another, and, in addition, peeling the bladder off the prostate. The junction of the membranous and prostatic urethra is admittedly torn or cut across, and the prostatic urethra removed with the tumour. The contention that the urethra is left intact by the operation has been abandoned, and need not now be discussed.

Those who maintain that this operation is not of the nature of total prostatectomy, explain the ease of the enucleation of the masses in the following way:

Growths of the nature of adenomata are formed within the prostate. These grow, and in their growth compress the outer portion of the gland until it forms a laminated fibrous envelope, in which there still remain compressed and partially-destroyed gland tubules. There is thus formed a 'capsule' to the adenomata, which, like adenomata in other parts of the body, are capable of being shelled out, the ease with which they are removed depending on the extent to which the encapsulation has taken place. When prostatectomy is performed, it is held that the enucleating finger penetrates to the surface of the growth, which is thus removed without any circumferential envelope, or the finger performs the enucleation by finding a line of cleavage within the 'capsule', with the result that a part of the 'capsule' is removed with the growth. The junction of the membranous and prostatic urethra is here again torn or cut across, and the prostatic urethra removed with the tumour.

The cavity left behind as the result of such an operation is, according to the first view, lined by the recto-vesical fascia, and according to the second view, by the expanded outer portion of the prostate.

In the chapter on the morbid anatomy, the formation of a fibrous envelope from the expanded outer portion of the prostrate has been traced. At the present moment it is necessary to ascertain how the appearances and the histological investigation of the tumours removed, and an examination of the parts left behind after prostatectomy, tally with the idea that 'total prostatectomy' is really an enucleation of adenomatous masses from within a 'capsule' formed of compressed prostatic tissue. The latter part of this subject has been fully treated of in vol. 55 of the *Pathological Society's Transactions.*

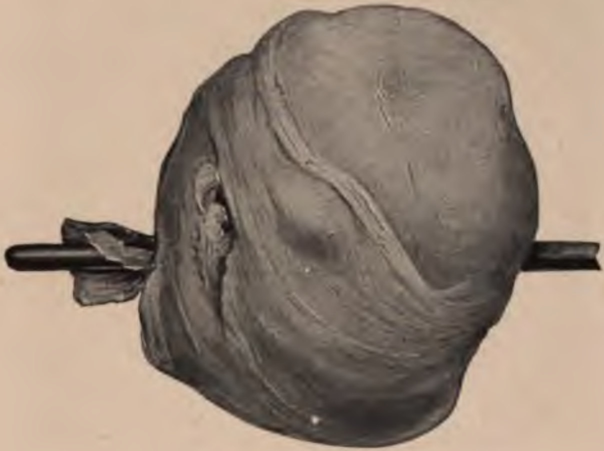

FIG. 49. (Natural size.)

The following is an extract from this paper:—

'Fig. 49 represents a specimen removed by the so-called operation of total prostatectomy. It was taken from a man, J. M., aged seventy-seven years, who had suffered from complete retention for six years. The weight of the specimen was 152 grams ($4\frac{1}{4}$ ozs.). The so-called "capsule" is seen to be composed of transversely-coursing bundles. The upper or vesical part of the specimen is smooth and rounded.

'Connected with the inferior part of the gland is a torn portion of the urethra which projects 13 mm. and partially surrounds the catheter which has been passed through the canal. The prostatic urethra is intact within the tumour.

'Fig. 50 is a cross section of the same made through the middle of the organ at right angles to the axis of the urethra.

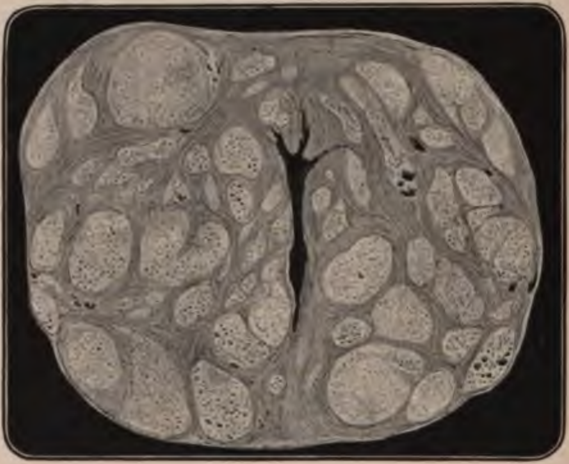

FIG. 50. (Natural size.)

It shows that the adenomatous tissue has practically surrounded the slit-like urethra, the wall of which is very thin and could not be separated from the adenomatous mass without rupture. At the circumference of the specimen and completely surrounding it can be seen the thin so-called "capsule". This may be considered a typical example of the parts removed by the so-called total prostatectomy.

'With this specimen compare the following obtained after death.

'Fig. 51 represents a section of a prostate, taken at right angles to the urethra, of a man, H. H., aged sixty years, who was admitted for the impaction of a stone at the junction of the prostatic and membranous urethra. The stone was removed by supra-pubic lithotomy. The patient died suddenly on the fourth day after operation. After death, the prostate and bladder were removed from the body, hardened in alcohol, and examined by means of sections cut at right angles to the urethra. The whole organ viewed from the outside forms a globular swelling without any indications of division into lobes. The greatest transverse diameter measures 6 cm.; the urethra along its length also measures 6 cm. The cut surfaces show a distinct envelope and within this is a glandular mass. The average thickness of the envelope is 0·3 cm. It is an exceedingly definite structure, and is distinctly laminated to such a marked degree that it admits of artificial cleavage for considerable distances along its lamellae.

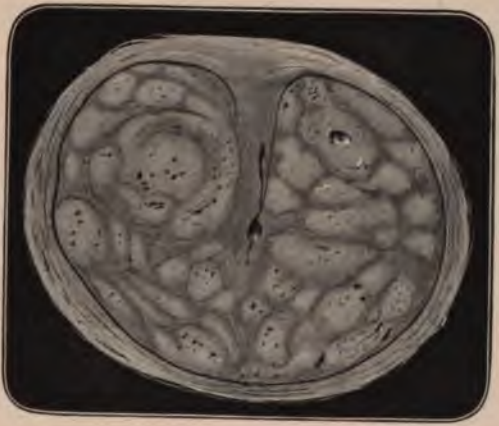

Fig. 51. (Natural size.)

'In the section taken through the centre of the enlargement the urethra is a vertical slit measuring 1·5 cm., and lies 2 cm. from the posterior and 1·5 cm. from the anterior border of the organ. The glandular substance is arranged in somewhat ill-defined lobules, absent on the anterior aspect of the urethra. In the last-named situation there is a septum of fibrous or fibro-muscular tissue surrounding the urethra, and continuous above or in front with the envelope. Towards the inferior or distal end of the organ this fibrous septum is less distinct, being broken up by processes of gland-tissue.

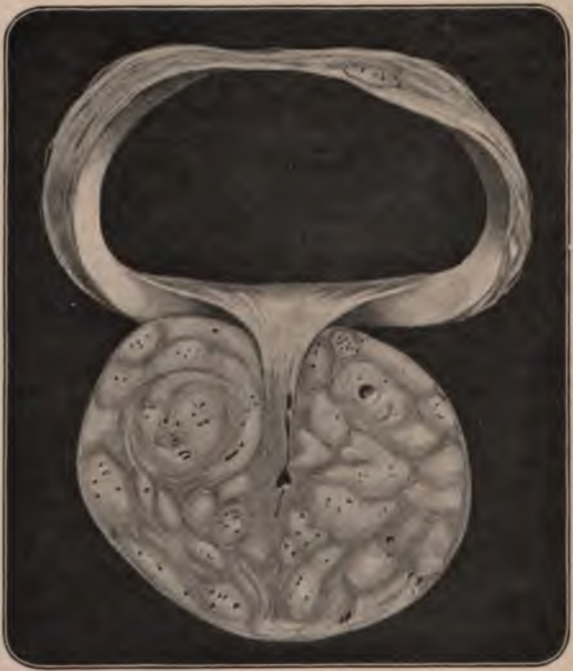

FIG. 52. (Natural size.)

'The median projection behind the urethral orifice is shown on a transverse section, carried through this part, to be inseparably continuous with the lateral portions.

'Fig. 52 shows the separation between the envelope and the glandular portion. The central mass containing the urethra has been shelled out from the envelope. This can be repeated in every section of the organ, so that ultimately the organ is divided into two parts, namely, the envelope, and a contained glandular mass, in which lies the urethra, the only line of continuity between the two being the thick anterior fibrous septum which is continued in from the envelope to join the peri-urethral tissue.

'No one can fail to be struck with the similarity of these two specimens (Figs. 50 and 51), the first obtained as the result of a surgical procedure, the other in the post-mortem room. The only difference is the thickness of the surrounding envelope; the central portions are identical; in fact, they appear to represent the same pathological change in different individuals.

'In the specimen removed in the post-mortem room, the nature of the envelope can be studied. Now this contains gland matter, as shown by the lenticular mass seen in the drawing, and by the fact that a microscope section taken at a point which is entirely fibro-muscular to the naked eye reveals the presence of flattened gland spaces (Fig. 53). This envelope therefore represents more than the outer non-glandular part of the organ.

'It can be studied further in Figs. 54 to 59.

'Fig. 54 represents the bladder and enlarged prostate taken after death from a man, F. H., aged eighty-three years, who died of uraemia. The front of the bladder and of the prostate has been removed by a coronal section.

'The two lateral adenomatous masses have been removed by digital separation, which was accomplished without any difficulty. The left of these masses has been replaced, but the line of its separation is indicated in the drawing. The lateral wall of the urethra was closely adherent and removed with it. It will be seen that there is a medium ridge left after the removal of the lateral masses; this is the posterior wall of the urethra, and is still covered with mucous membrane. The walls of the bilocular cavity left after the removal of the lateral adenomatous masses have a very considerable thickness.

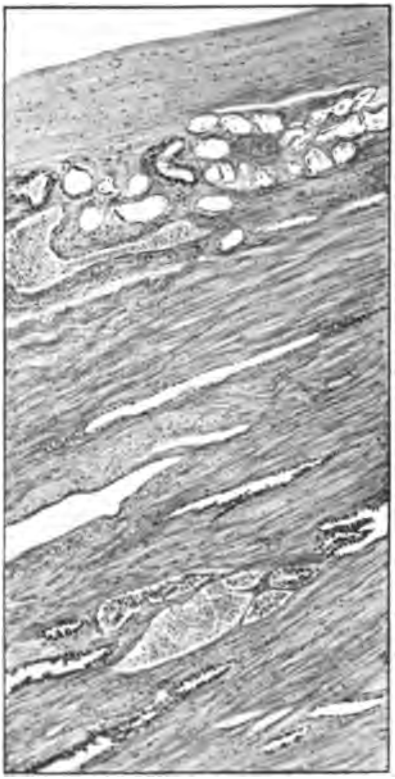

FIG. 53.

This is especially the case behind the urethra on both sides, as seen in the lowest portion of the drawing. On the left side and behind is seen a portion of the prostatic plexus of veins.

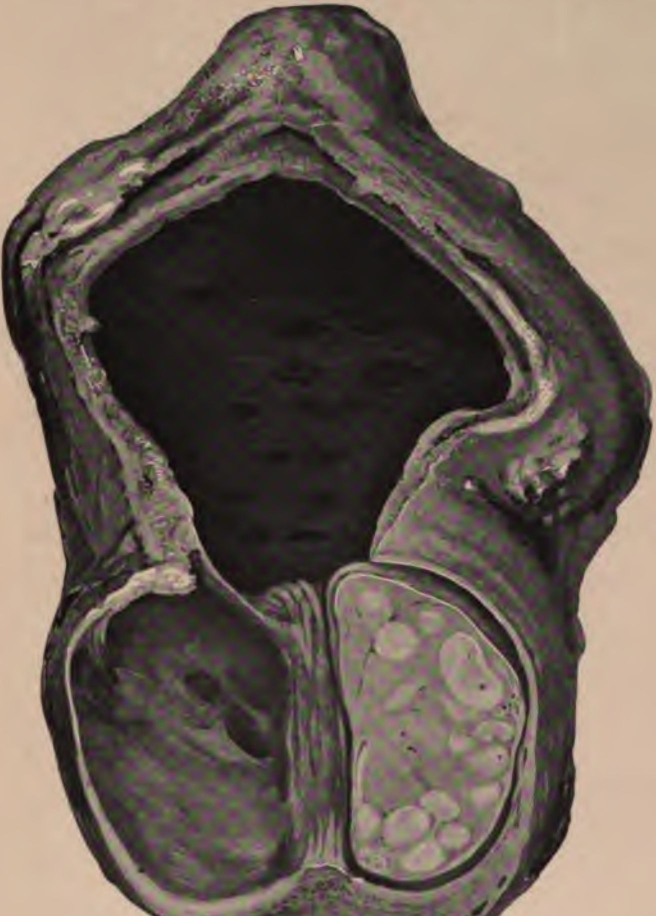

FIG. 54. (Natural size.)

'A further examination of the specimen showed that the walls left after the ablation of the lateral masses were capable of a further division. With the finger and a blunt dissector, the division was carried out until the part of the envelope immediately surrounding the lateral masses was completely isolated. The result of this isolation is shown in Figs. 55 and 56.

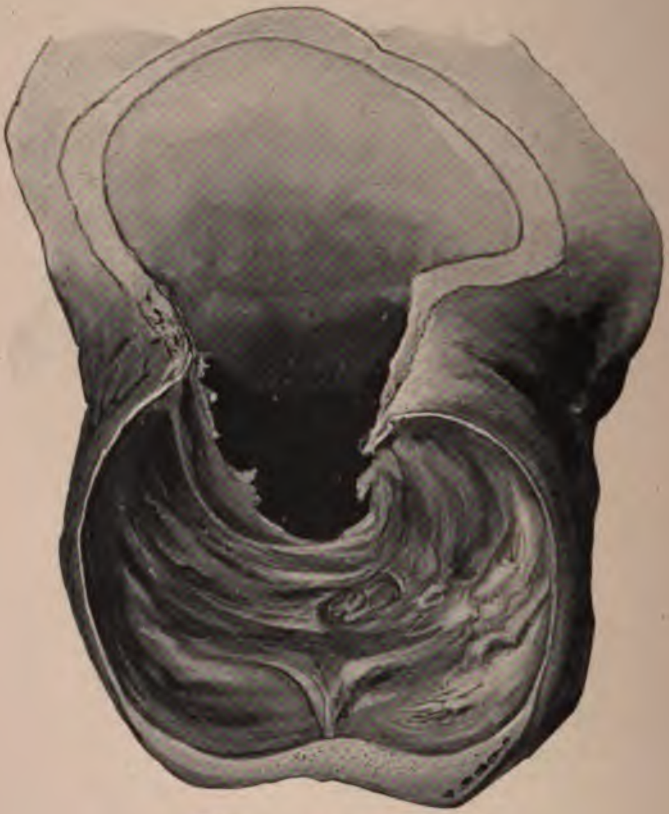

FIG. 55. (Natural size.)

'With this portion of the envelope has come away the posterior wall of the urethra, and with it, of necessity, the terminal portions of the ejaculatory ducts. This shell or envelope shows naked-eye evidences of gland-tissue, for it contains an adenoma

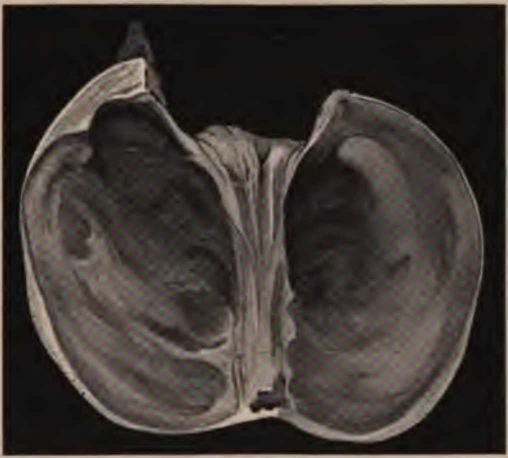

FIG. 56. (Natural size.)

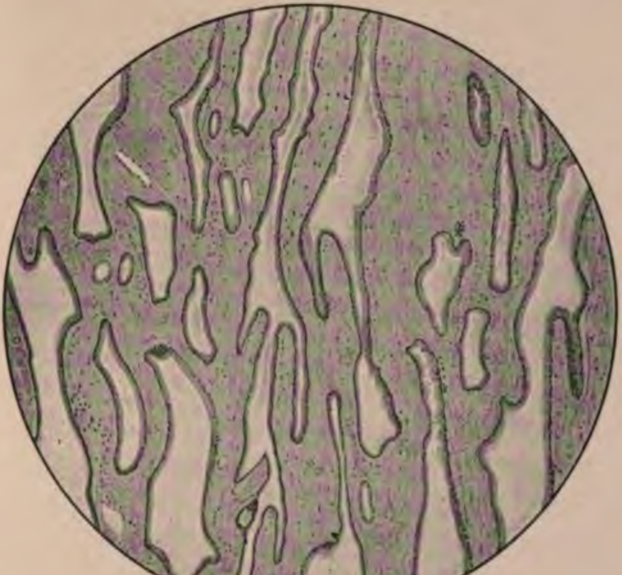

FIG. 57.

at the uvula vesicae; and a microscopic section of the envelope taken from the right side, where only fibrous tissue is visible to the naked eye, reveals the presence of flattened gland-spaces lined with columnar epithelium (Fig. 57).

'The outer surface of the envelope shows circularly-coursing bundles of fibres. A drawing of these fibres has not been made, but a reverse of the outer surface can be seen in Fig. 55, which represents the parts after the removal of the envelope described. The wall of the now unilocular cavity left by the removal of the adenomata and of the envelope is still a definite structure, and has an appreciable thickness even at its thinnest part, while behind it measures 0·6 centimetres in plane of section. The texture at this spot is spongy, and a microscopic section shows the presence of a considerable amount of flattened gland-tissue, which is not much altered from the normal (Fig. 58).

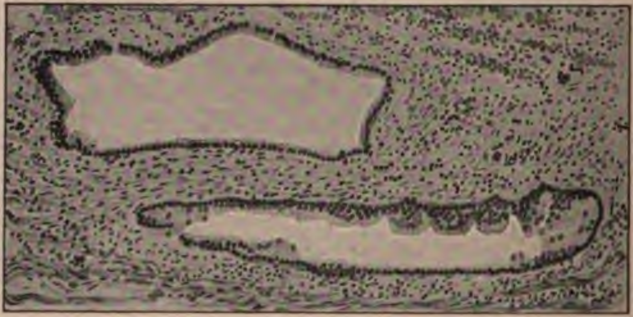

FIG. 58

'Still more externally can be seen the prostatic plexus. If the two adenomatous masses were replaced in their envelope, it would be seen that the whole would resemble the parts that are often removed in the so-called total prostatectomy, namely, two lateral adenomatous masses encompassed by an envelope that is most strongly marked at the equator of the mass, and presenting transversely coursing fibres.

'It has been pointed out that the specimen obtained by prostatectomy and shown in Fig. 50 differs only from the specimen shown in Fig. 51, and obtained after death, in the thickness of the "capsule". Now this latter envelope is laminated, and can be split in any part of its thickness. If the finger had entered in the middle of the cut surface of the envelope, as shown in the section, the adenomatous mass would have come out surrounded

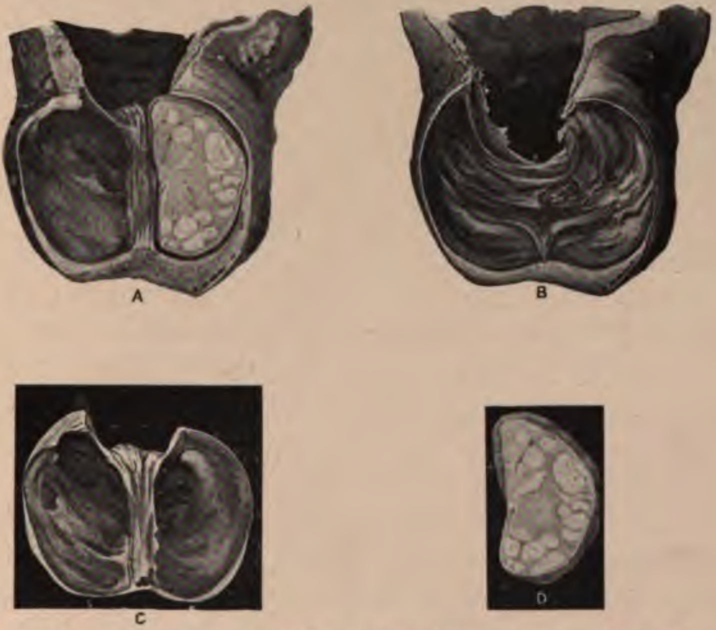

FIG. 59. The preceding figures have been reduced and placed side by side so that their relations can be more easily appreciated. A. The original specimen in which one lateral adenomatous mass has been removed. B. The bladder and outer part of the 'capsule'. C. The inner part of the 'capsule' usually removed with the tumours. D. One lateral adenomatous mass; the other was exactly similar but is not shown.

with an envelope, the fibres of which would have formed circularly-disposed bundles, and the surface would have resembled that seen in the specimen represented in Fig. 49.

'The amount of capsule removed with such a tumour will simply depend on the thickness of the envelope and the depth to which the finger happens to have penetrated in the process of enucleation. Fig. 59 demonstrates that, in such a case as this, each adenoma could have been removed separately, provided that the finger had reached to the surface of the adenomatous masses. If the finger had penetrated less deeply, and had entered the envelope, the parts removed would have consisted of two lateral adenomatous masses bound together by the innermost layers of the envelope.'

By the help of specimens removed from the dead body, the growth of the adenomata, the formation of a definite laminated envelope, and the alteration in the shape and environment of the urethra have been traced. It has been shown that the glandular masses, surrounded by the innermost layers of the envelope enucleated from the parts removed after death, correspond accurately to those removed by the so-called total prostatectomy in the living subject. It must, therefore, be concluded that the parts left behind in these two procedures correspond. Now in the case of the parts removed after death, after such a removal as that just described, there is left behind a definite envelope. This envelope has been shown to contain glandular tissue, and therefore to have been formed by the periphery of the organ, and to represent more than the outer non-glandular cortex of the organ. It therefore follows that after the so-called total prostatectomy, an envelope formed of expanded prostatic tissue is left behind, and bounds the cavity formed by the removal of the tumour.

*The different appearances presented by the 'capsule'.*

There is no doubt that appearances of the 'capsule' differ in different cases. Fig. 60 is a drawing of a bladder obtained from a male aged eighty-one years, who was suffering from retention, on account of which supra-pubic cystotomy was performed. The man was gravely ill at the time of admission, and died in a few hours. At the post-mortem examination there was intense haemorrhagic cystitis, double hydro-nephrosis, and a dilated left ureter. The bladder and the prostate were removed from the body. An opening was then made into the bladder, and prostatectomy performed in a way identical with that adopted on the living subject. Enucleation was very easy. The tumour removed measured 9·5 centimetres in transverse diameter, and 6·5 centimetres in the vertical. It was of the twin-tumour type, the surface was lobulated, and showed portions of a fasciculated envelope. The prostatic urethra lay within the tumour.

Fig. 60 shows the bladder and the 'capsule' left after the removal of the adenomatous mass; the 'capsule' is a thin but very definite structure, quite unlike the fibrous sheath of the prostate. The portion of the front wall has been cut away, and through the opening can be seen the space left by the removal of the tumour. At its summit this cavity communicates with that of the bladder by an opening having a diameter of 4 centimetres. Below can be seen the lumen of the membranous urethra, shown in the drawing as a triangular aperture. In one spot in the anterior surface of the 'capsule' can be seen a small lenticular mass. Microscopic section of this mass shows it to consist of glandular tissue. The presence of an isolated nodule of prostatic tissue would of itself, perhaps, be of little significance, but flattened and atrophic remains of gland-tissue are shown by microscopic sections to exist in portions of the 'capsule' altogether fibrous to the naked eye. Lying outside

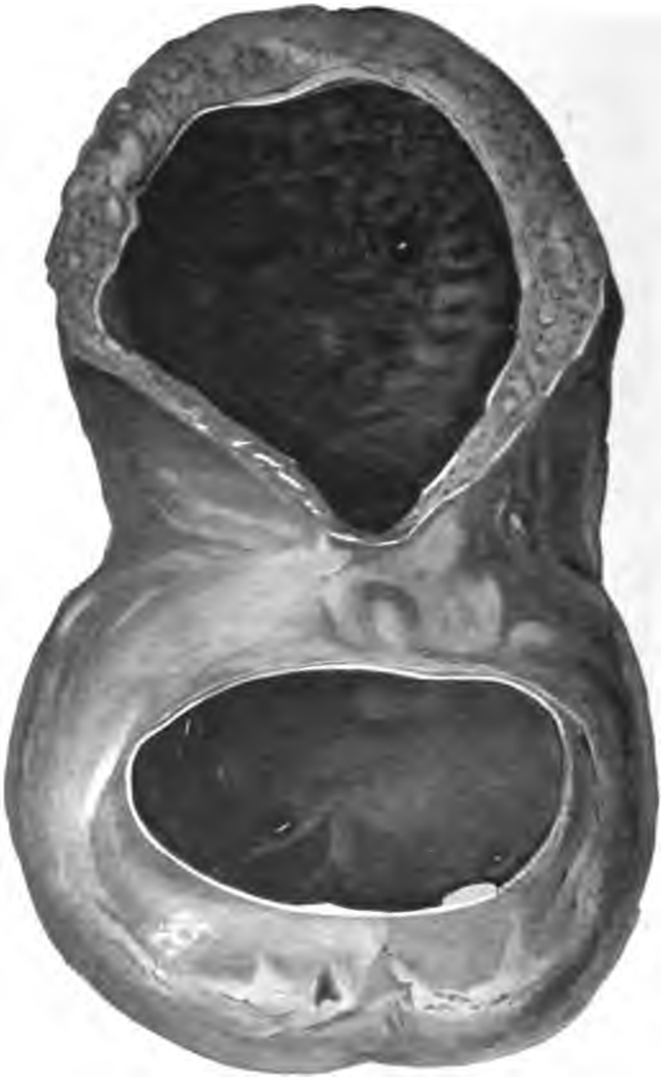

Fig. 60. (Slightly reduced.)

the 'capsule' were layers of areolar tissue, and, between their planes, the veins forming the prostatic plexus. It is to be noted in this case that the prostatic enlargement was of long standing, the tumour of large size, and the 'capsule' a dense fibrous but comparatively thin structure. The internal surface of this 'capsule' was smooth. The ease of enucleation, the dense fibrous condition of the 'capsule' and the smoothness of its internal surface are to be attributed to the length of duration of the enlargement and the size of the growth.

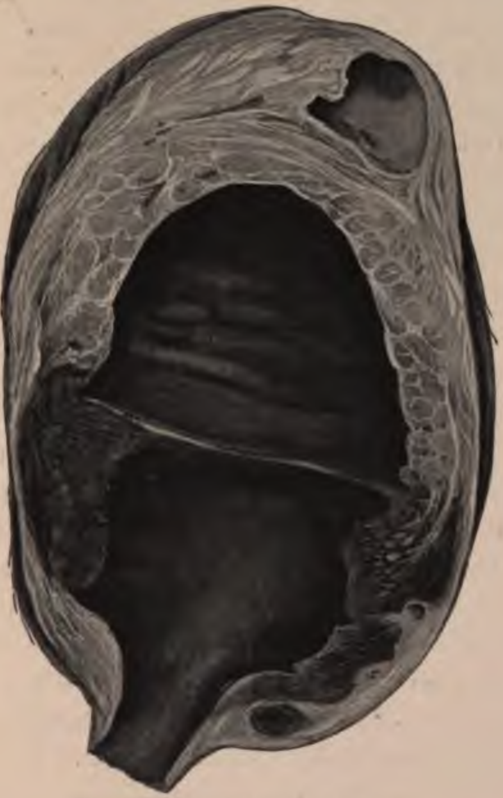

Fig. 61. (Natural size.)

Fig. 61 shows a coronal section of the bladder and 'capsule' in a case in which the history was of short duration and the tumour of small size. It was obtained from a case of supra-pubic prostatectomy which proved fatal from sepsis of the genito-urinary tract a few days after the operation. The patient was sixty-eight years of age, and had presented symptoms for about a year. The tumour weighed 36 grams, and was of the twin-tumour type, being surrounded by thin 'capsule' and containing the prostatic urethra. It was, therefore, of similar nature to the last. The 'capsule' left behind in the body is of thicker but less dense structure, and its internal surface much rougher than in the last case. It will be seen that on the left of the picture the wall of the 'capsule' is infiltrated with blood for rather more than half its extent. On the right side this infiltration is continued down almost to the membranous urethra. Towards the top both walls show muscle fibre, depicted white in the drawing. Microscopic examination confirms the appearances as regards the upper part, but shows that the wall of the 'capsule' in its inferior part contains degenerated glandular spaces. It follows, therefore, that in this specimen the walls of the 'capsule' are composite in their origin, being partly formed of the bladder wall and partly from the prostate itself. Posteriorly the bladder wall does not enter in so large a degree into the formation of the 'capsule', which is here almost entirely made up of compressed prostatic tissue. The explanation of the roughness of the inner surface of the 'capsule' is apparently to be sought in the want of encapsulation of the tumour, due possibly to its small size, and to the comparatively short duration of the enlargement, whereby the outer portion of the prostate was not subjected to pressure for so long a period as in the former case. The explanation of the composite nature of the 'capsule' wall is found in the insinuation of the enlarged prostate through the sphincter, into the bladder. In dealing with the morbid anatomy it was pointed out that the enlarged prostate, by stretching the internal sphincter and gaining the cavity of the bladder, might actually raise the floor of that viscus above its normal level, the mucous membrane of the bladder passing off the walls of the viscus on to the prostate at some level above the internal sphincter. The intra-vesical portion of the prostate would, therefore, lie in contact with the bladder wall. Under such conditions the upper part of the 'capsule' would be formed by the bladder wall, and the lower part by the expanded prostate.

It is now necessary to see how the appearances of the tumours removed coincide with the idea that they are adenomatous masses.

### THE DIFFERENT TYPES OF TUMOUR REMOVED BY PROSTATECTOMY.

When prostatectomy is performed by enucleation the tumours removed conform to certain well-defined types. It will be remembered that, in the normal state, gland tissue is found on every side of the urethra except immediately in front, though even here it is sometimes met with (see Figs. 4 and 32).

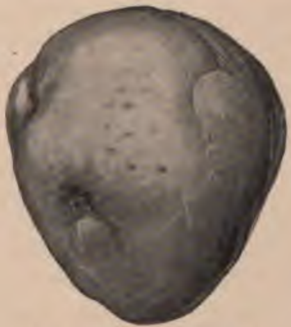

FIG. 62.[1] (Natural size.)

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[1] I am indebted to *The Practitioner* for the use of this block.

Type I. *The Single Adenomatous Tumour.*—Fig. 62 is a drawing of such a tumour which was enucleated from the lateral mass of a prostate. It is the simplest form of tumour. It may develop in any part of the organ where gland tissue is situated, but is usually found on one side of the urethra or the other, and if small may be removed without injury to this canal. The surface is as a rule smooth and lobulated, but may show some circumferential fibres. Fig. 63 is a semi-diagrammatic scheme showing the development of the single adenoma.

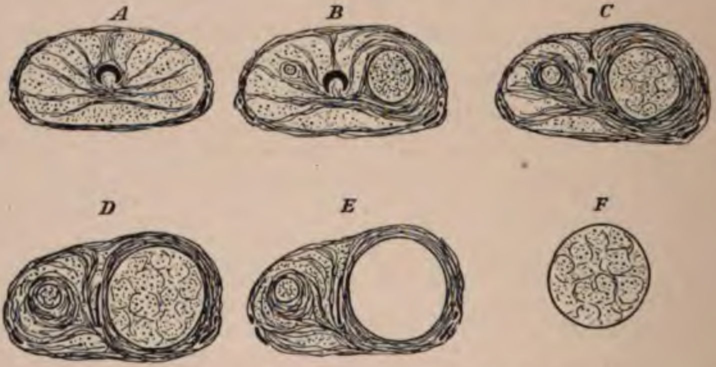

FIG. 63.[1] Semi-diagrammatic scheme showing the development of the single adenoma, and its effect on the prostate. *A.* Normal gland. *B.* Commencing change in both lateral parts of the gland. *C.* Same as *B*, but more advanced, one adenoma has outgrown the other. *D.* Adenoma fully developed. The circumferential part of the gland has been expanded and compressed to form the 'capsule'. *E.* Shows condition of gland after removal of the adenoma. The cavity left by the removal of the adenoma lies entirely within the prostate; the prostatic plexus of veins is untouched. *F.* The enucleated tumour.

Type II. *The Twin Tumour.*

(*a*) *Without a 'capsule'.*—The parts here removed consist of two adenomatous masses, one from each lateral part of the organ. They may be of equal or unequal size. Their surfaces are smooth and lobulated, but may present some fibrous strands. If they are of any size the mucous membrane of the urethra is found lying on their opposed surfaces (Fig. 64).

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[1] I am indebted to *The Practitioner* for the use of this block.

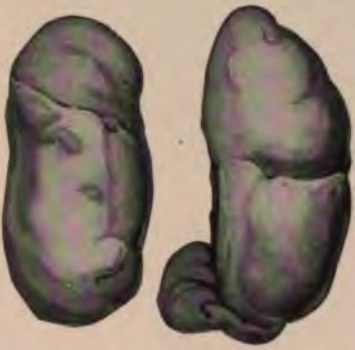

FIG. 64.[1] (Reduced ⅓.)

(*b*) *With partial 'capsule'*.—In this type the two adenomata are joined, either on their anterior or posterior surfaces by a hinge of fibrous tissue, on the surface of which and on the opposed surfaces of the adenomata, is usually to be found the torn urethral wall.

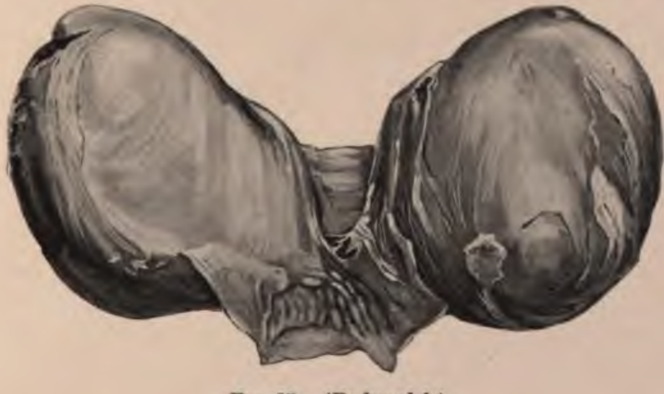

FIG. 65. (Reduced ⅓.)

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[1] I am indebted to *The Practitioner* for the use of this block.

Fig. 65 shows such a tumour, the two adenomata being joined posteriorly by an incomplete 'capsule'. The torn urethral wall can be seen to lie partly on the tumours and partly on the 'capsule'.

(*c*) *With a complete circumferential 'capsule'*.—Here the adenomata are bound together at their equators by a broad fibrous band. The poles are bare and show a lobulated surface. The urethra is contained with the tumour. This is, perhaps, the commonest type of tumour (Fig. 66).

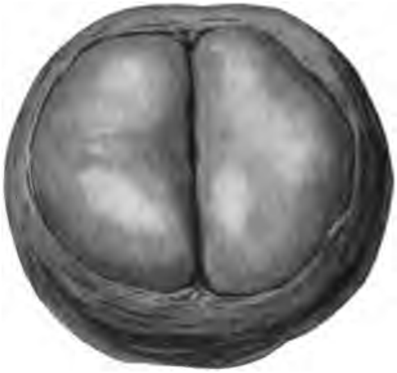

FIG. 66.[1] (Slightly reduced.)

Type III. *The Horse-Shoe Tumour.*

(*a*) *Without a 'capsule'*.—In this type the tumour removed is shaped like a horse-shoe, the heels of which are directed forwards. The adenomatous change has taken place at the side and behind the urethra, but has not invaded the anterior commissure. The toe of the shoe lies in the position usually assigned to the 'third lobe' (Fig. 68).

(*b*) *With a 'capsule'*.—This is similar to the last, except for the presence of a capsule round the tumour which keeps together the two heels of the horse-shoe (Fig. 69).

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[1] I am indebted to *The Practitioner* for the use of this block.

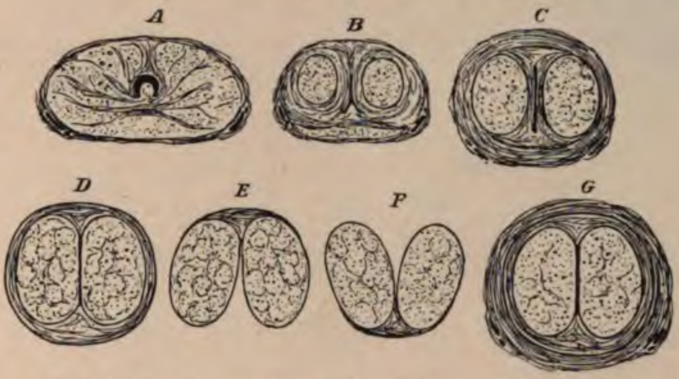

FIG. 67.[1] Semi-diagrammatic scheme showing the formation of the twin-tumour type. *A*. The normal gland. *B*. Adenomatous masses have formed one on each side of the urethra, which is already distorted. The portion of the gland outside the adenomata is showing signs of compression, as evidenced by the disappearance of the gland tissue and the concentric direction of the fibres. There is still a thick layer of tissue between the adenomata and the urethra. *C*. The adenomata have increased in size, and approached the urethra, which has now become a simple slit. The 'capsule' has appeared, there being no appearance of gland tissue in the circumferential part of the organ. *G*. The adenomata are in apposition, being separated only by the attenuated urethral walls. The 'capsule' is a thick, definite structure, on the outside of which can be seen the prostatic venous plexus. The dark line represents the point of cleavage in this capsule when such a tumour as *D*—twin tumour with complete 'capsule'—is removed. *F* and *E* represent twin tumours with the capsule present in front or behind. Such tumours are removed if the enucleating finger penetrates to surface of the adenomata, but leaves a portion of the 'capsule' attached in front or behind.

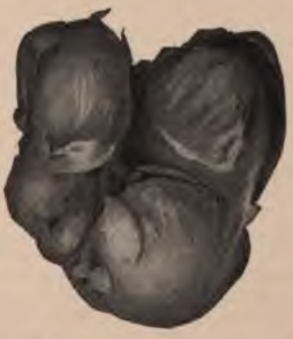

FIG. 68.[1] The 'toe' of the horse-shoe or posterior part of the tumour is at the bottom. (Slightly reduced.)

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[1] I am indebted to *The Practitioner* for the use of these blocks.

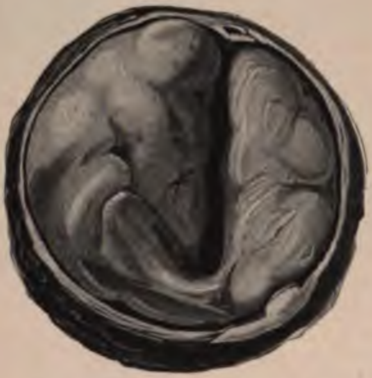

Fig. 69.[1] (About $\frac{2}{3}$ natural size.)

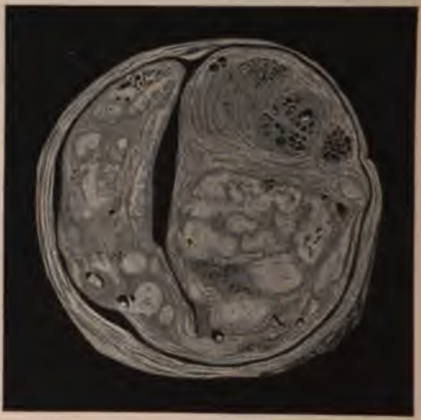

Fig. 70.[1] Cross section of Fig. 69.

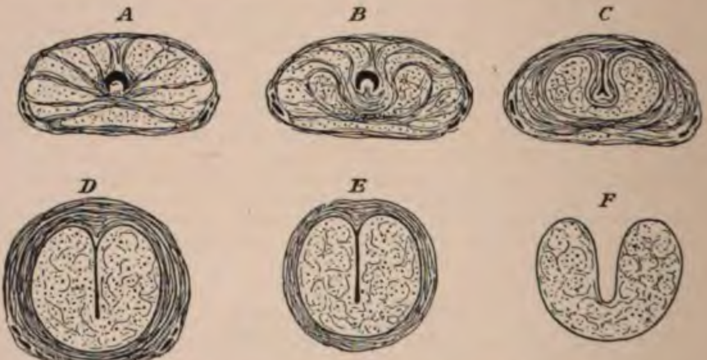

Fig. 71.[1] Semi-diagrammatic scheme showing formation of the horse-shoe type of tumour. *A.* Normal gland. *B.* Commencing adenomatous change behind and at the sides of the urethra. *C.* Adenomatous change has advanced, and is now plainly visible. The urethra has been flattened from side to side. The gland tissue is disappearing from the peripheral portions of the tumour. *D.* Great increase in the size of the adenomatous mass. The urethra has become a linear slit, and the walls of the canal have disappeared. The outer portion of the gland has become a laminated 'capsule'. The prostatic venous plexus is seen to be on the outer side of this 'capsule'. The dark line indicates the line of cleavage taken by the enucleating finger of the operator when the tumour (*E*) is removed. In this case the horse-shoe tumour is surrounded by a 'capsule', which binds the two arms of the horse-shoe together, and so keeps the urethral walls in apposition. *F.* Similar tumour removed without a 'capsule'. The adenomatous mass has opened out, so that the urethral walls are no longer in apposition, and the canal is ruptured along its anterior surface.

[1] I am indebted to *The Practitioner* for the use of these blocks.

Type IV. *The Ring Tumour.*

(*a*) *Without a 'capsule'.*—Here the adenomatous change has taken place on every side of the urethra. In these cases it is probable that gland tissue existed in front of the urethra, and that it underwent an adenomatous change in common with that lying at the sides of, and behind, the urethra.

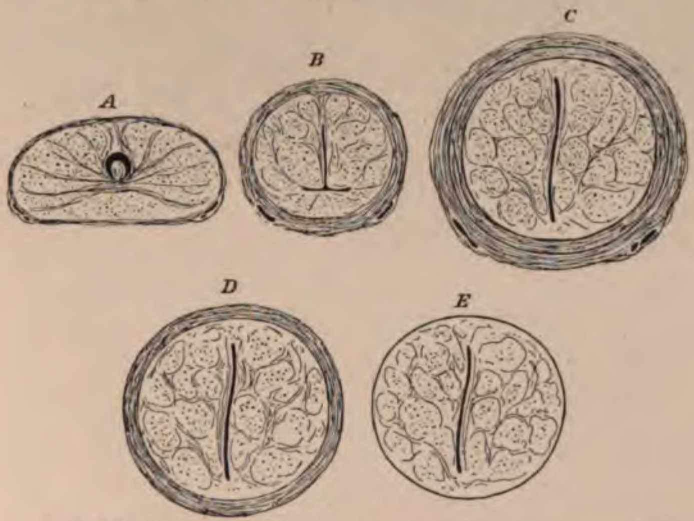

FIG. 72.[1] Semi-diagrammatic scheme showing the formation of the ring type of tumour. *A.* Normal prostate. *B.* Adenomatous formation has taken place on all sides of the urethra, which has become so distorted as to be triradiate on cross section. The outer portion of the gland shows no macroscopic signs of gland tissue, and has become the laminated capsule. *C.* Shows the increase in size of the altered organ. The urethra is a simple slit. The dark line shows the line of cleavage used in the enucleation of (*D*), a ring-type tumour with a well-marked capsule. *E.* A ring-type tumour without capsule, which would have resulted if the enucleating finger had penetrated to the surface of the adenoma.

(*b*) *With a 'capsule'.*—The appearances are similar to the last except that the tumour is covered about its equator with a fibrous 'capsule' (see Fig. 49).

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[1] I am indebted to *The Practitioner* for the use of this block.

Type V. *Multiple Tumours in a thick 'capsule'.*—Fig. 73 is a drawing of a transverse section of a specimen removed by enucleation. It shows three adenomatous masses embedded in a thick 'capsule'. This presents fibrous-looking circumferential strands and prostatic tissue which still exhibits some of its normal spongy nature. The urethra has been much distorted by the adenomata.

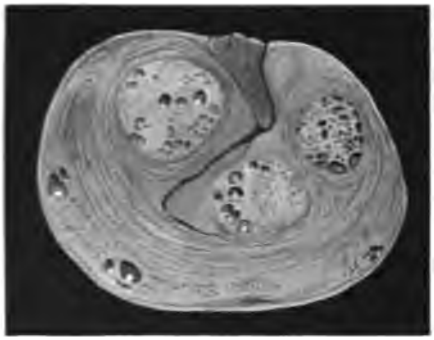

FIG. 73. (Natural size.)

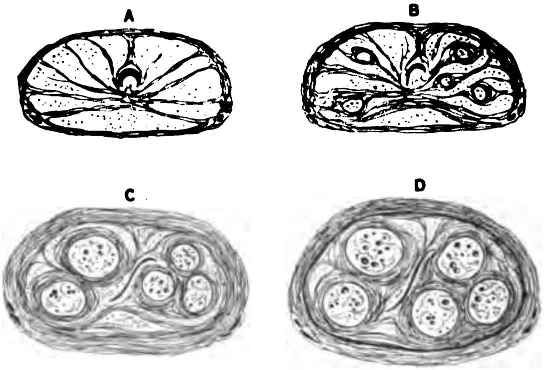

FIG. 74. A. Normal gland. B. Numerous commencing adenomatous masses. C. Same as B but more advanced. D. Adenomata fully developed and lying in a mass of compressed prostatic tissue. The dark line shows the line followed by the finger in the process of enucleation.

Fig. 74 is a diagrammatic scheme showing how such a specimen is produced.

The tumours just described, although differing much in shape, were all removed by a similar operative technique. The types are constant but present no similarity to the prostate gland. By means of the diagrams it has been shown how an adenomatous change, taking place in the gland, can account for all the various forms.

It may therefore be said that the study of the specimens removed by prostatectomy supports the contention enunciated earlier in this chapter.

It will now be convenient to summarize the facts in favour of the contention that 'total prostatectomy' is the enucleation of adenomatous tumours from within a 'capsule' formed from the expanded outer portion of the prostate.

1. *The degree of ease with which such tumours are enucleated.*

The adenomatous theory explains the separation between the bladder and the coverings of the tumour on the one hand, and the tumour itself on the other. It also explains the variation in the ease of enucleation and the varying thickness of the 'capsule', either removed with the tumour or left behind in the body.

2. *The ease of enucleation of small tumours.*

In some cases the mass removed consists of a twin tumour provided with a 'capsule' containing the urethra, but weighing little more than the normal prostate. Under these circumstances simple enlargement can hardly be adduced to account for the ease of separation between the bladder and the tumour.

3. *The explanation of the ease of enucleation in some cases and difficulty in others, the prostate being equally enlarged in both cases.*

If the operation under discussion were really a total ablation of the gland, two tumours of equal size should be enucleated with equal ease, since the ease of removal is said to depend on the increase in size. On the adenomatous theory it is only necessary to suppose that encapsulation has failed to take place in the case in which difficulty is encountered.

4. *Varying thickness of the 'capsule'.*

The adherents of the total prostatectomy theory maintain that the capsule is formed either from the recto-vesical fascia or the cortex (outer non-glandular portion of the organ).

The 'capsule' left behind after prostatectomy is a very definite strong structure of considerable but varying thickness, having on its outer side the prostatic plexus of veins. The situation of these veins shows at once that the 'capsule' lies internal to the outer layers of the fibrous sheath, and therefore this 'capsule' could only be formed from the inner part of the fibrous sheath or the cortex of the prostate. These two structures would have to undergo a great thickening to resemble the 'capsules' shown in Figs. 52 and 66. The formation of the 'capsule' by expansion of the outer portion of the prostate by an adenomatous growth, easily explains the varying thickness both of the parts left behind in the body and that found on the tumour after removal.

5. *The absence of bleeding.*

The prostatic plexus of veins has been shown to lie outside the 'capsule', and the finger in an ideal operation never leaves the confines of the gland, and so cannot cause haemorrhage from injury to veins.

6. *The absence of extravasation of urine after operation.*

The interposition of a strong fibrous capsule between the urine and the fascial planes of the pelvis explains the absence of infiltration.

7. *Avoidance of stricture.*

If the prostate were completely removed there would be a complete solution of continuity between the bladder and the membranous urethra. All that we know concerning the results of untreated ruptures of urethra would lead us to suppose that such a condition would lead to a fibrous stricture of the worst type. The 'capsule', however, forms a connecting link between the musculature of the bladder and that of the membranous urethra, so that the urinary canal can never be said to be absolutely interrupted.

W. G. Richardson (*Development of Anatomy of the Prostate Gland*, 1904) has described a case in which the prostate was cut away with scissors, and in which the prostatectomy was really total. This operation was followed by an impermeable stricture.

8. *The various yet recurring forms of tumours enucleated by an identical process.*

This has been dealt with in the section dealing with the different types of tumour, and it need only be pointed out here that adenomatous growth will account for a small tumour isolated from one lateral lobe as easily as it will account for a complex tumour formed by two large adenomata surrounded by a 'capsule' and containing the urethra.

It has been said that the crucial test of a total prostatectomy is the failure to find evidences of prostatic gland tissue in the parts left behind in the body after operation. The author has been at pains to examine all specimens which he could obtain from patients who had died after operation. In all he was able to demonstrate the presence of compressed gland tissue, and under such conditions as to exclude such gland tissue being isolated portions accidentally left behind in the process of an operation which would otherwise have been a total prostatectomy.

Even the failure to find signs of gland tissue in the 'capsule' need not be taken as irrefutable evidence of a total prostatectomy. It is easy to suppose that, in cases of large growths, the stretching experienced by the outer portion of the prostate might destroy all evidences of gland tissue. The capsule produced by large thyroid tumours is often so thin as scarcely to be recognizable, yet, such tumours, when once the capsule which carries in its layers many large veins, has been entered, can be enucleated by the unaided finger and without section of thyroid tissue.

### DESCRIPTION OF PROSTATECTOMY BY ENUCLEATION IN THE LIGHT OF THE FOREGOING OBSERVATIONS

(*a*) *In cases in which the urethra is removed within the tumour* (Type II (*b*), (*c*); Type III (*a*), (*b*); Type IV (*a*), (*b*)).

The bladder being opened above the pubes, the finger of the operator tears through the mucous membrane, which alone in the case of a well-marked intra-vesical projection lies between the finger and the surface of the adenomata. When the intra-vesical projection is absent or but little marked (see Fig. 28) some of the muscular tissue of the bladder wall will have to be penetrated before the adenomata are reached.

The finger next passes between the growth and the internal sphincter. This process is then repeated on every side until the upper part of the growth is separated from the bladder, the urethral and vesical mucous membranes being necessarily torn apart. The enucleation then progresses by a deepening of the cleft thus formed, the finger passing down on the surface of the growth or between the layers of the expanded outer portion of the prostate until the apex of the gland is reached.

The walls of this circular cleft will be formed on the outer side by the expanded prostatic tissue below, and the bladder wall above; and on the inner side by the adenomata or by the portion of the outer part of the prostate still lying on their surface.

The adenomatous mass containing the urethra will now be separated from its attachments, except at its lowest part, where the prostatic urethra is continuous with the membranous. Section of the urethra will complete the operation.

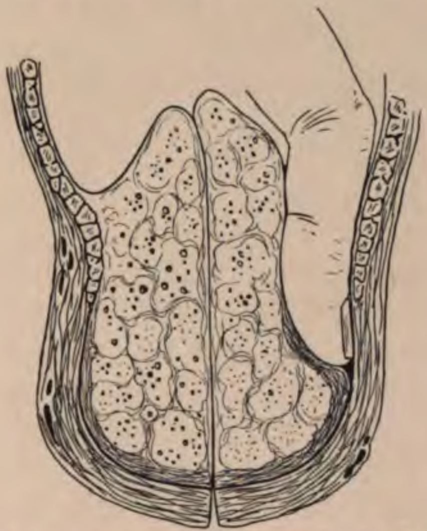

FIG. 75. A semi-diagrammatic representation of the process of enucleation. The finger has separated the top of the prostatic adenoma from the bladder wall, and has just entered the line of cleavage in the 'capsule'. A dark line shows the path the finger will take to complete the process.

(*b*) *In those cases in which an isolated tumour or two tumours without a 'capsule'* (Type I, Type II (*a*)) *are removed.*

Here the process is similar, only the finger reaches the surface of the adenoma, and keeps in contact with it until the removal is complete. It may happen that the urethra is not injured, but in most cases the urethral mucous membrane is so attenuated on the surface of the tumour that the finger finds its way into the urethra, the wall of which is thus removed on the adenoma.

# CHAPTER XII

## CARCINOMA OF THE PROSTATE

THREE important questions have to be settled in this connexion.

(1) The proportion of carcinomatous to other enlargements of the prostate.

(2) The possibility of diagnosis.

(3) The feasibility of relief by operative measures.

It has been stated by the French surgeons that carcinoma, or at least atypical adenomata, occurs in 10 per cent. of the cases of prostatic enlargement.

In a series of sixty-four cases in which a careful microscopical examination was made in the Pathological Department of St. Thomas's Hospital, carcinoma was found in eight cases, and if to these be added a case in which carcinoma was found after supra-pubic cystotomy, but in which no microscopical examination was made, the figures become sixty-five and nine respectively. The numbers above quoted may be too small to show a just proportion, but they evidently point to the fact that carcinoma is not a very uncommon disease. It must be remembered, however, that they only include cases which were submitted to operation; they do not include all the cases of prostatic enlargement met with in a certain period.

MORBID ANATOMY.—The carcinoma is of the spheroidal or of the columnar type. The difference is one of degree only. They are often, indeed usually, present in the same specimen. If the growth is very atypical the spheroidal type prevails. If, on the other hand, the departure from the normal is not so great, the columnar is most in evidence.

In the first class (Fig. 76), the whole microscopic appearances are so altered from the normal that it would be difficult

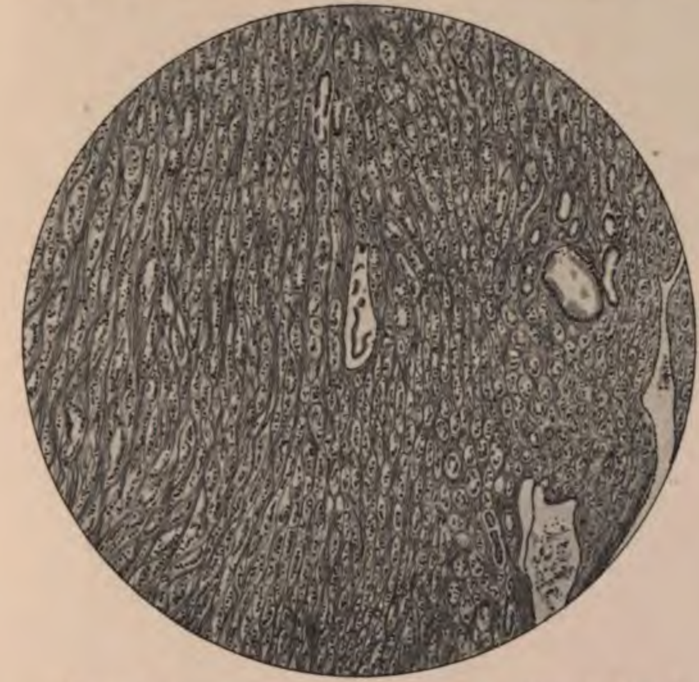

FIG. 76. A microscopic section showing spheroidal-celled carcinoma of the prostate. The normal structure of the gland is lost. The field is almost entirely made up of small epithelial cell-masses lying in a delicate stroma. A few less altered alveoli are to be seen.

to recognize the organ from which the section was taken. The epithelial masses are totally irregular in shape and size; they are round, oblong, or star-shaped. They may be made up of many cells or contain but few.

In some sections epithelial cells lie between each stroma cell, while in others large areas of fibrous tissue intervene between the aggregations of the cancer cells.

In the second class the departure from the normal is not so marked, and something of the normal structure of the gland can still be recognized. In the same microscopic field can be seen, on the one hand, alveoli which, although somewhat irregular in shape, possess a lumen, present plications of the wall, and an epithelium of a sub-columnar type. And, on the other hand, alveoli of very irregular outline filled with masses of polygonal epithelial cells. This latter variety has a less

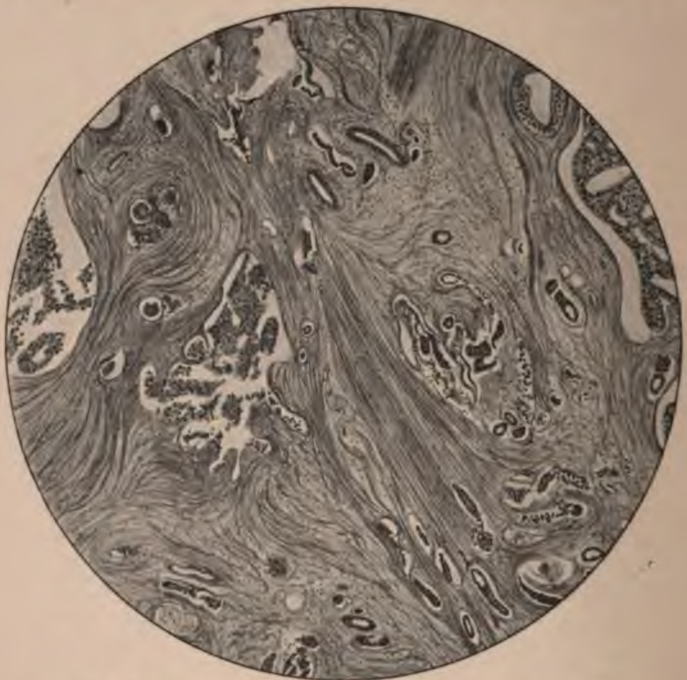

FIG. 77. A microscopic section showing spheroidal and columnar-celled carcinoma of the prostate. There is a greater proportion of stroma than in the last figure. Many of the alveoli have a lumen and are lined with a sub-columnar epithelium.

malignant appearance than the former, and may possibly be akin to the malignant adenoma of continental writers.

Fig. 76 is taken from a case under the care of Mr. Makins. It is curious to note that, although it represents the more malignant type, it was obtained from a specimen which shelled out. The finger was able to complete the removal of this tumour in the usual way, except for a small area on the rectal surface of the gland, where the use of scissors was necessary. The part of the prostate left behind and forming the capsule felt distinctly nodular. This tumour weighed 147 grams, and differed in no degree from the usual appearances presented by a typical 'twin tumour' in a capsule. The patient died fourteen days after operation.

Fig. 77 was obtained from a case in which enucleation proved impossible. The details of this case will be found on pp. 200-1. Carcinoma arises under two conditions.

(1) Direct from the normal gland tissue.

(2) In a pre-existing adenoma.

(1) This variety is especially met with in small prostates. The consistence of the gland may be but little altered, or it may be of considerable hardness. The size again varies. In an early stage the gland is not much, if at all, enlarged, but in advanced cases it may form a large mass. The shape of the gland in the early stages does not show any marked departure from the normal. When incised it is usually tough, and the cut surface shows strands of fibrous tissue and whitish-yellow glandular areas, but no signs of encapsulation; in fact, the appearances may not differ greatly from those seen in the simple non-encapsuled form of enlargement (Fig. 78).

(2) This variety, as would be expected, is found in glands that have undergone considerable enlargement. The size, shape, and appearances are hardly, if at all, different from

those observed in the benign adenomata. The cut surface shows the familiar yellow-white encapsuled bodies, and also a main external 'capsule' (Fig. 79). From the naked-eye

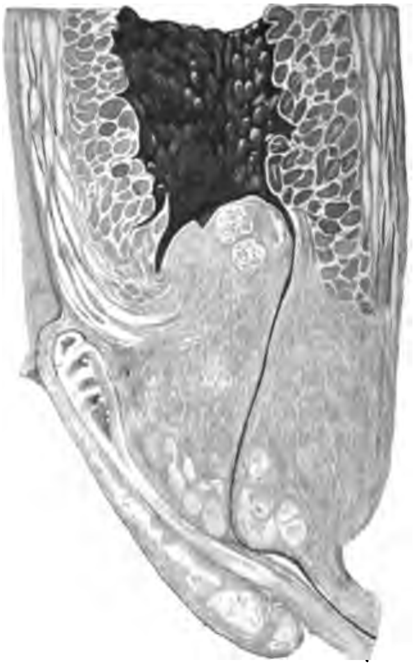

FIG. 78. A sagittal section through a bladder and prostate. There is a slight intra-vesical projection. There is no sign of encapsulation, but numerous yellow-white areas have appeared which are most numerous toward the bottom of the gland. The fibrous tissue is slightly translucent. The spongy nature of the normal gland is entirely lost. A microscopical section shows spheroidal-celled carcinoma. The patient was sixty-five years of age, and had presented symptoms of prostatic trouble for about five years. There was a secondary growth in the right pleura.

appearances it is impossible in the early stage to diagnose carcinoma, and it is only when sections are examined under the microscope that the malignant nature of the growth is discovered (see Fig. 80).

The microscopical appearances of these two forms of malignant growth may not differ in any degree. Perhaps the columnar type is more common in the latter, and the very atypical spheroidal variety in the former.

*Extension of the growth.*

The growth may remain for a long time limited to the gland, and, while so limited, produce metastases in distant organs. When it passes outside the confines of the prostate by local extension it does so almost invariably in an upward direction. The extension may be through the posterior part of the base of the organ to reach the neighbourhood of the vesiculae seminales, or it may pass more anteriorly and invade the bladder in the vicinity of the internal meatus, usually in the trigonal area. It first makes its appearance here as small sub-mucous nodules. This mode of invasion is well shown in the following case :—

R. E. B., aged sixty-five, had suffered from frequency of micturition for five or six years, which had lately become very troublesome. There was involuntary passage of urine at night and intermittent micturition. Residual urine to the extent of twenty ounces was present. The prostate was not enlarged upwards nor did it bulge the rectum. The surface was smooth and the consistence but little harder than normal.

A supra-pubic cystotomy was performed. There was a slight intravesical projection and the internal meatus just admitted the little finger. Bimanually the prostate was slightly enlarged. The surface of the trigone was studded with small nodules and their palpation recalled to mind the sensation produced by tuberculous nodules on the peritoneum. Enucleation proved impossible. A portion of the gland behind the urethra was cut away with punch forceps to remove the valvular nature of the opening. The patient was discharged with the wound closed and micturition a little more frequent than normal. Microscopic sections showed columnar-celled carcinoma of the prostate.

The growth spreads beneath the mucous membrane and the nodules enlarge, coalesce, and break down, so that an ulcerated surface is formed, into the centre of which opens the urethra. The growth then mounts up over the lower part of the bladder.

As illustrating this condition, the following case may be narrated, for the use of which I am indebted to Mr. Battle :—

J. C., aged eighty-four, complained of the dribbling away of the urine. A catheter had been in use for five weeks before admission. There had been some very slight bleeding from the urethra following voluntary propulsive efforts. The prostate was enlarged, hard, and nodular on rectal examination. The bladder was opened above the pubes to relieve the patient, who died shortly afterwards. The bladder and prostate were removed at the autopsy. Around the internal meatus was an irregular pitted ulcer. On the front of the viscus the growth had not yet ulcerated and could be seen extending beneath the mucous membrane as a whitish mass. The prostate was enlarged and showed adenomatous encapsuled areas, one of which, measuring 1″ × 1½″ and lying on the rectal surface, had broken down. The growth had also extended up on to the base of the bladder, involved the vesiculae seminales, and blocked one ureter.

It was a spheroidal-celled carcinoma.

This case is also an instance of the extension of the carcinoma through the posterior part of the gland to involve the vesiculae seminales and the base of the bladder. Young has described this process, and pointed out that it forms a plaque-like mass which can be felt, by rectal examination, to reach up from the base of the prostate.

Further extension takes place through the areolar tissue of the pelvis. The growth passes outward to the walls of the pelvis and produces fixation of the organ.

The pelvic, iliac, and lumbar glands are infected, and metastases take place in distant organs. In one case that came under my care a single metastatic deposit was present in the pleura, while the primary growth was still completely within the prostate. The glands had escaped infection.

It has been said that metastatic growths are often seen in the bones. They have not been met with in the cases that have come under my notice, but in these cases the bones have not been submitted to a systematic examination, so the secondary growths might have escaped notice. There were, however, no gross evidences of bone lesion.

### SYMPTOMS AND DIAGNOSIS.

The duration of symptoms in these 9 cases mentioned above was, on an average, 15 months, while in 47 cases of benign disease the average was 3½ years. The extremes in the malignant cases were 2 months and 5 years. The difference in duration is striking, but the numbers are small. The ages of the malignant cases lay between 58 and 84 years, the average being 69 years. In all the cases, the earliest noted departure from the normal was frequency of micturition. In five instances, acute retention was the immediate cause of the patient seeking advice; in one instance it was haematuria and neuralgia in the thighs; and in one instance, sciatica. In only three cases did hardness and nodularity of the gland as felt per rectum raise a suspicion of carcinoma before operation. In only two of the nine cases had there been any haemorrhage. In one there was slight urethral haemorrhage on straining, and in the second it was fairly profuse, but only of three weeks' duration, although the prostate was of huge size and firmly fixed to the surrounding structures.

In the present state of knowledge, a positive diagnosis of carcinoma of the prostate while it is yet confined to the limits of the gland is not possible. The early symptoms differ in no way from those seen in the benign form of the disease; in fact, carcinoma may become engrafted on a simple adenomatous process. Frequency of micturition is first noticed, and is usually continued, with an occasional attack of retention, until the latter state or frequency of micturition causes the patient to seek relief. Haemorrhage is not a frequent symptom, or not more frequent than in the benign form. Young, in a series of forty cases, says it only occurred eight times; in the author's series it only occurred in two cases, in one of which it was extremely slight.

The size of the organ offers no help. Carcinoma is found both in the large and small tumours, in those that show intravesical projection, and those that do not. Hardness and nodularity of the rectal surface should raise a suspicion. If, in addition, the vesiculae seminales and the base of the bladder are indurated, or there is fixation of the prostate, the diagnosis of carcinoma is fairly certain. Unfortunately the last symptoms only occur when the growth has passed the confines of the gland, and is, therefore, in a very unsatisfactory state for treatment.

Pain seems likely to be met with in many cases. It is, of course, necessary to exclude the pain brought on by a calculus, cystitis, or the difficulties of micturition. It may be present in the penis, testes, rectum, or perineum, but when it occurs in these situations it is not so suggestive as when it is felt in the thighs or in the course of the sciatic nerve. It cannot be stated that pain is present while the growth is yet confined to the gland, though from the following case (for the details of which I am indebted to Mr. Corner) it would appear possible:—

H. B., aged fifty-five years, suffered from pain down both legs for four months. There was also a frequency of micturition and a slight difficulty in starting the act. This latter symptom was, however, only admitted after cross-examination. There was no haematuria. The prostate per rectum felt hard and fixed. The surface was smooth, but the outline somewhat irregular. Rectal examination was undertaken to try and find an explanation of the pain the patient felt in his thighs, as up to that time no suspicion of any disease of the prostate was raised. The bladder was opened above the pubes and a small non-ulcerative tuberous excrescence was found on the left side of the internal meatus. Enucleation was impossible and the left half of the gland was removed with scissors. It was exceedingly hard and grated on being cut. Convalescence was rapid and the patient was discharged with normal micturition. A microscopic section of the growth is shown in Fig. 77. It was a columnar-celled carcinoma. Four months later the pain was but slight and caused little inconvenience. Eight months after operation the pain had returned with considerable severity. Twelve months after operation the patient was evidently going down hill, and died two months later. There was never any haematuria or obstruction to micturition.

Cystoscopic examination should be very useful in suspicious cases. The presence of nodules on the trigone and about the internal meatus, or the discovery of a ragged ulcerated surface in the same situation, would be an almost certain sign of carcinoma.

When all the means of examination have been tried there will still be a great difficulty in arriving at a diagnosis by clinical methods. A supra-pubic cystotomy may not give any further help unless invasion of the trigone with or without ulceration, as mentioned above, has taken place. If the operator proceeds to removal and enucleates the enlargement with the finger, he cannot with certainty say that such tumour is non-malignant. In one of the cases of carcinoma referred to above, which occurred in the practice of Mr. Makins, who kindly allowed me to examine the prostate in the process of enucleation, the growth did shell out with comparatively little difficulty, and only required scissors at its posterior part. The mass removed had the typical appearance of a twin tumour, and consisted of two lateral adenomata containing the urethra, and bound together with a 'capsule'. It proved to be a spheroidal-celled carcinoma.

The patient died about fourteen days after operation, and at the post-mortem examination secondary growths were found in the pelvic glands and the lungs.

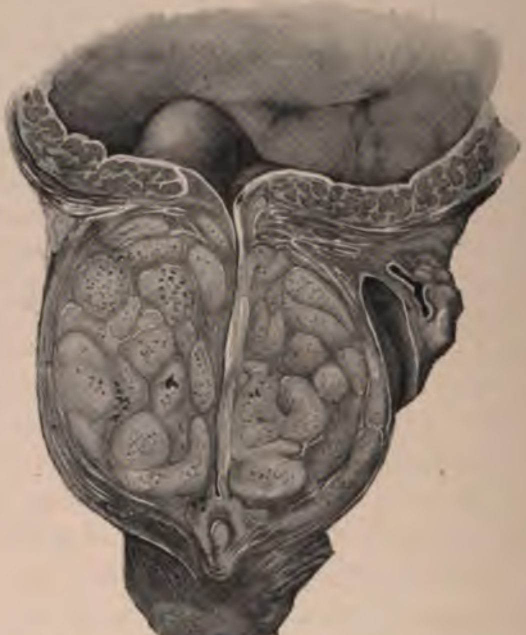

FIG. 79. A coronal section of a bladder and prostate taken through the urethra. The cut surface shows the lobulation usually seen in the simple adenomatous form of enlargement. There is a well-marked external 'capsule'. On the left of the picture this structure is laminated, but on the right it is homogeneous in appearance. The lower part of the central mass is proved by microscopical examination to be carcinomatous.

Fig. 79 is a vertical coronal section of a bladder and prostate taken through the urethra. It was obtained from the post-mortem room, and the clinical history is unknown.

It is remarkable in two ways. It has all the appearances of an ordinary adenomatous prostate, and shows a well-marked main external 'capsule'. When cut, it was thought to be a simple tumour, and it was not until microscopic sections were examined that it was found to have undergone a malignant change. It was then clear that the inferior part of the tumour, on the right of the drawing, was carcinomatous. Sections were subsequently cut from the 'capsule' in proximity to the carcinoma, and it was evident that the carcinoma had invaded this structure almost up to its junction with the bladder wall.

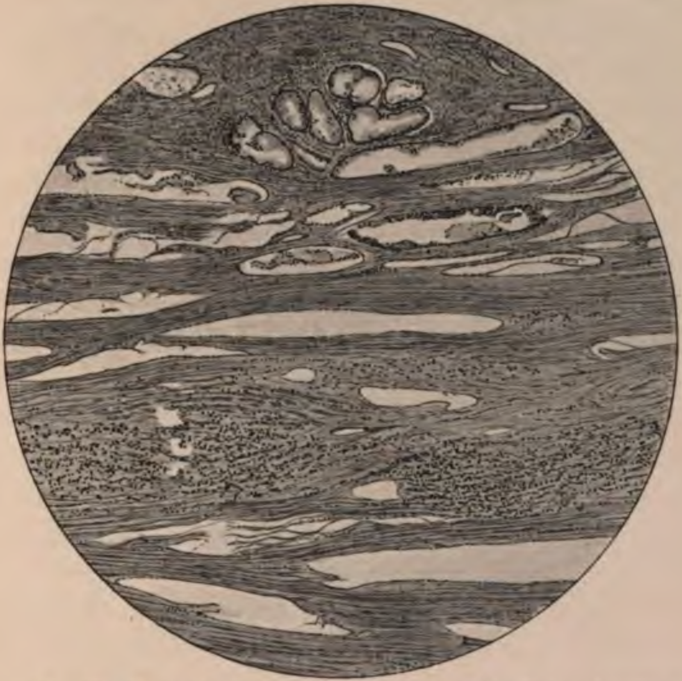

FIG. 80. Shows the infiltration of the 'capsule'. It is a drawing of a microscopical section of the junction of the 'capsule' and central mass taken at the inferior and right-hand side of Fig. 79. The upper part belongs to the central mass, the lower to the 'capsule'. The former shows slightly altered and atypical alveoli, the latter spaces in the fibrous tissue, some of which are filled with masses of epithelial cells.

It will be seen by a study of the illustration that the 'capsule' on the right of the drawing is of a more homogeneous nature than on the other side, due to the infiltration by the growth. This fact has a very important bearing on the prognosis of carcinoma occurring in an enucleable tumour such as this.

The adenomatous mass might well have been shelled out if the patient had come under operation, and unless the particular part of the growth, where lay the carcinoma, had been examined microscopically, no suspicion would have arisen as to the malignant nature of the growth. Microscopic sections taken from the upper left part of the drawing show simple adenomatous change.

If the prostate, whether but little or grossly enlarged, does not admit of enucleation, and recourse to removal by morcellement is necessary, the operator is yet uncertain whether he is dealing with a carcinoma or a non-encapsuled form of growth. Microscopic examination is the only method of making the diagnosis.

It would seem, therefore, that carcinoma, which is still confined to the gland, cannot with any degree of certainty be diagnosed. A hard, fixed, and nodular condition of the organ, associated with pain, is likely to prove malignant, while a large, resilient, soft prostate is probably of a benign nature.

## TREATMENT

The treatment of the condition is in its infancy. It is beset with difficulties. Among others are the difficulty of diagnosis, the severity of the operation necessary to remove the diseased organ, and the age of the patients.

The only surgical method of dealing with carcinoma is the ablation of the organ in which it occurs. It therefore follows that carcinoma of the prostate can only be dealt with satisfactorily by an excision of that organ.

Young (*Johns Hopkins Reports*, October, 1905) has shown that this is possible, and has performed it by the perineal route, which is apparently the only practicable method.

Time alone can show whether complete prostatectomy can give such results as to make it worth while submitting patients to such an ordeal. Taking it as granted, for the sake of argument, that the results will justify the treatment, there are still many difficulties in the way of its application.

For the operation to be successful, the disease must still be confined to the gland. Those cases in which there is fixation of the prostate or an extension on to the base of the bladder, are inoperable, and can be excluded.

Those cases in which, from hardness or nodularity of the organ, carcinoma is probable, could be submitted at once to a complete perineal prostatectomy.

Next, there are instances in which, from the presence of nodules or ulceration of the trigone, the diagnosis is only made after a supra-pubic cystotomy ; these, if the growth was not too advanced, could be submitted to operation by abandoning the supra-pubic and adopting the perineal route, provided that the consent of the patient had been obtained. This is hardly likely to have been asked for, as no suspicion of malignancy may have been entertained before operation. Under these conditions the operation would have to be postponed to a later date.

Thirdly, there are those cases in which the diagnosis can only be made by the microscope.

Carcinoma may be met with, both in the encapsuled and non-encapsuled form. In the latter, or in the partially encapsuled form, a suspicion may arise, and a fragment be sent for immediate report by the pathologist. If carcinoma is reported, the same difficulties would have to be faced as in the last case, where carcinoma was discovered when the bladder was opened. It must, however, be carefully borne in mind that non-encapsulation does not mean malignancy.

When the growth is well encapsuled, and shells out readily, it cannot be said that carcinoma is absent. It is probable that such a tumour would be removed and sent to the pathologist, who would only report after some days. As was shown when describing Fig. 79, the 'capsule' of such a malignant enucleable tumour would probably be infiltrated, and therefore require removal. The removal of such a shell would certainly be more difficult than that of a complete organ.

In this country the supra-pubic route is most in favour for treatment of the adenomatous form of enlarged prostate. It seems that total excision of the organ is only feasible by the perineal route. In order to save a change of route in the middle of an operation, it will have to be considered whether carcinoma is of sufficient frequency to make it advisable to adopt the perineal method in all operations on the prostate.

The question is further complicated by the fact that the histological appearances of carcinoma are not altogether settled. There is the class of case which has been termed adeno-carcinoma, on account of an atypical development of the epithelium. It is still uncertain as to how far these cases really are malignant, and, until this is settled, it would seem that total excision is a very severe measure to adopt for their treatment.

The operation of total excision of the prostate, as practised by Hugh Young, is shortly, as follows: The organ is exposed from the perineum, the membranous urethra is divided, and the prostate and the vesiculae seminales isolated. The bladder is opened immediately above the anterior portion of the prostate, and this organ, vesiculae seminales, and a ring or cuff of the lowest portion of the bladder, are excised. The bladder is then sutured to the membranous urethra, and the remaining part of the organ closed posteriorly with sutures. The operation takes two hours. Young reports four cases, one of which died within a month; the others were successful, and lived eighteen, five, and five months respectively after the operation.

### PROGNOSIS

This is far from bright. Of the nine cases mentioned at the beginning of the chapter, six were submitted to prostatectomy. In three instances the growth was enucleated with comparative ease. Of these one died in fourteen days, the second recovered normal micturition, but succumbed of a recurrence within the year, and the third has only been lately submitted to operation.

Of the cases treated by piecemeal removal, the first died in seven days, the second cannot be traced, and the third is too recent for any conclusion to be drawn.

These operations were in no sense radical; they are certainly not encouraging. Time alone can show if the treatment advanced by Young will prove successful.

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